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Additional Applications of the Weston Instruments. WE published recently a series of articles on the use of the Weston voltmeters and ammeters for making various measurements other than those for which they were intended. This has brought forth an interesting contribution showing that the limitations for application were not reached even in that paper. Those who have such instruments will find this quite instructive matter. There are doubtless still other applications of which we would be glad to publish descriptions if our readers will send them to us.

Switches in High Tension Work. A CONTRIBUTOR gives an interesting description of how an arc of the 10,000-volt alternating currents used in London is extinguished by the attendants at the Deptford stations. It must resemble an onslaught on a vicious rat or a mad dog, and may be interesting to look at from a distance, but there are doubtless very few electricians who would not prefer to have some one else do it, to doing it themselves. To the serious mind, however, it is instructive when we compare this system with the different principle adopted in the Lauffen-Frankfort transmission, in which the currents were much more vicious. In the former the switches, cut-outs and controlling apparatus are in the high tension circuits, while in the latter they were all, with the exception of some simple fuses, in the low tension circuit. This is a very important point to consider in designing such plants, and is well worth careful consideration.

"Half-Baked" Electricians. A SHORT time ago the Central Theatre in Philadelphia was burned to the ground by fire, causing the loss of a number of lives. The usual enemy of electricity is, of course, ready to attribute the cause to the "mysterious" and "dangerous" electric current. Fortunately, however, the careful and conscientious manager of the Edison station, Prof. Marks, has proof that their current was turned off before the time of the fire, thus completely exonerating them from any blame in the matter. His explanation, however, brings out another point, showing that all the fools are not dead yet. An apparently ignorant, reckless and totally unreliable person who degrades the profession by assuming to be an electrician, experimented in that building without, apparently, the slightest regard for even the most ordinary precautionary measures. It was probably by mere chance that he did not set fire to it at the time. It is just such men who, if allowed to go at large, do the mischief which brings a bad name, in the eyes of the public, to the whole electrical industry. In the interests of the profession such men should be branded with the significant name they have made for themselves and be exiled forever from among electricians. Such men certainly deserve the name of "half-baked" electricians, which Prof. Marks applied to them some time ago.

Wattmeter Corrections. OWING to the difficulties sometimes experienced in measuring the energy of an alternating current, which are due to the properties of those currents, the wattmeter has become a much more important measuring instrument than it was with direct currents, which are readily measured with volt and ampère meters. Its application, however, is not at all simple, as errors are easily met if the conditions are not well understood. It cannot be applied like a direct current volt or ampère meter by any electrician, but requires a knowledge of the construction of the instrument, its constants and its behavior as well as a knowledge of the nature of the currents and the other apparatus in circuit. Even then a correction must sometimes be made. For these reasons a thorough discussion of this subject is not only of interest but also of great importance in practice, as the alternating current wattmeter may probably be made a very useful and reliable instrument. We publish this week a criticism of a paper which appeared some weeks ago, and, coming as this does from the laboratory of Professor Kittler, the author quoted by Mr. Danielson in his recent paper, it cannot fail to be of interest, particularly as the writer, Mr. Friese, gives some apparently useful practical deductions. Among other things he shows how the introduction of a condenser may simplify matters, and also how the construction of the instrument may be improved so as to overcome some of the objections.

An Improvement on the Steam Engine. WHILE steam engine builders have been increasing the efficiency of their engines little by little by additional expansion, condensation, etc., approaching only very slowly a point which, though low, will probably never be exceeded, the gas engine makers have not been idle. Tests are just now being made by impartial and capable experts with a 100 h. p. gas engine (said to be the largest ever built) in combination with a gas generating apparatus, the total combined guaranteed efficiency of which is given as 1¼ pounds of coal per horse power per hour. Whether this refers to brake or to indicated horse power is not stated, but we believe the former is meant. This certainly is a remarkably good result and makes it probably the cheapest practical method of power production known at present, for such capacities. We have good reason to believe that the results are not overestimated and that the tests will confirm them, if they do not give even a better figure. The gas is obtained from a new apparatus which uses no steam under pressure. A blower is used to force air over the hot water obtained from cooling the gas, and the air thus saturated with vapors from the hot water is blown through the burning coal in the gas generator. Unless objectionable features of some sort are found, which will tend to balance the saving of coal, this new generator cannot fail to take a very important place in the production of electricity, for which we are now unfortunately still so dependent on the shamefully wasteful steam engine.

Some Recent High Speed Railroading. PROMPTED probably by the near approach of a formidable rival in the form of electric locomotives, the builders of steam locomotives are continuing to make a little progress. Although the improvements are doubtless looked upon as important ones in the minds of steam engineers, nevertheless the actual increase of speed gained thereby, though not small, is by no means a great step in the solution of the problem of interurban rapid transit. Like the efficiency of the steam engine, the speed of a modern locomotive is already very near to a limit which it cannot exceed from the very nature of its construction. Just as the speed of a revolving wheel, and therefore that of an electric motor, is limited quite definitely by the bursting of the parts, so the speed of the present locomotive is limited by the hammer blow of the reciprocating parts. Besides this the danger of breakage increases very rapidly for higher speeds of steam locomotives. An increase of their size also requires heavier rails and stronger bridges. The best results so far obtained on steam roads were probably those made a few days ago by engine No. 870 of the Empire State Express on the New York Central Railroad between here and Albany. Mr. Sinclair, editor of *Locomotive Engineering*, who took the indicator diagrams while running, stated that the maximum speed reached was, for four miles, 78 miles an hour. He believes this to be the fastest ever made by a locomotive drawing a train on a level. He stated that it generated 1,600 h. p. (probably meaning indicated) and consumed 2½ pounds of coal per horse power per hour. This certainly is a remarkably good efficiency for a steam locomotive. He thinks that a speed of 100 miles could be reached with only one car. The total run of 143 miles to Albany was made in 140 minutes. The locomotive weighs 100 tons with its tender; its drivers are 6½ feet in diameter. The indicator diagrams taken are said to be the most satisfactory ever obtained from a locomotive at such a speed. Unfortunately, however, this speed was calculated from observations made by the ear and by feeling, and may, therefore, not be very exact.

Futile Direction of Progress. BESIDES the inevitable perpetual motion man, who is beyond reach of any argument or advice, even from his best friend, there is a class of men who are too intelligent to be included among the former, but who, nevertheless, are working in a direction in which a careful investigation would show that their attempts must prove futile from the very nature of the matter. Among these is the primary battery man, who claims to obtain more energy out of his battery than the zinc and solution are capable of giving. This subject, however, has been thoroughly discussed before, and we are pleased to see that the number of such misled inventors is rapidly becoming small. But there is another point quite similar, which we fear is not so clearly understood, as we notice that it is occasionally brought out by inventors who do not regard our fundamental laws as being unquestionable, or who do not clearly understand such laws. It is the belief that more than 746 watts can be obtained to the mechanical horse-power. The inventors who entertain this idea are misled by the fact that they think this figure 746 (or, more correctly, 745.941) was determined originally by experiments with our present forms of dynamo, and may, therefore, be improved upon by a departure from these forms. This, however, is an entirely wrong impression; any attempt to obtain a larger figure must necessarily be a waste of mental energy, besides involving useless expenditure of money. This number is obtained from calculation pure and simple, depending, therefore, on no experimental determination (other than the value of gravity, which it includes). The value for the mechanical horse-power in foot pounds per minute is fixed by *definition*, as are also the values of the electrical units; this number, 746, is merely the connecting link between the mechanical horse-power and the electrical units, precisely as the number 3.2809 is the connecting link between feet and metres, and it would be just as useless to try to get more feet out of a metre as to get more watts out of a horse-power. Inventors who are working in this direction had therefore better stop at once and find out how this figure is obtained before wasting their time upon any futile attempts to get what cannot be got from the very nature of the case.

One of the Effects of the Edison Telephone Patents. WHATEVER may be the outcome of recently issued Edison Telephone patents at the hands of the Supreme Court or of Congress in their effect on the telephone monopoly, there is no doubt that one very good result will be the overhauling of some of the very objectionable laws and rules of our Patent Office. There is no doubt that there will be a fight next year, as there is an army of inventors, capitalists and enterprising business men lying dormant at present, waiting only for the expiration of the Bell patent to enter the field of the telephone business. There will be doubtless a rush into this field like the rush of settlers to newly opened lands in the West and Southwest, and there will be a fight of many against one powerful corporation. This fight will bring to light some of the methods, rules and laws of our Patent Office which have been the cause of trouble to the honest, or the means for the dishonest to practice their shrewd and illegitimate tactics. One of the chief sources of trouble is the great length of time it takes the Patent Office to attend to matters. This is merely a matter of having a sufficient force, and as the Patent Office is said to be more than self-sustaining, there is no reason why Congress should not vote it sufficient money to pay for the required number of officers. As it is now it takes months before the first examination of an application is made. This is certainly inexcusable. Another objectionable feature is the opportunity which dishonest applicants and attorneys have to delay action in cases when the delay is to their advantage; this will be more difficult to overcome. Perhaps the best solution would be to adopt the recommendation made some time ago, to let the life of the patent date from the day of application, instead of from the date of issue; but this would be proper only if the office be provided with a sufficient force to handle cases promptly. The limitations of our patents by those in foreign countries is a question which has been before the courts before and has already been decided several times in favor of the law as it stands; in this, therefore, a change is not so likely to be made, although as it is intimately connected with the principles of free trade and protection, a change of policy of the government in the latter may also cause a change in this Patent Office law.

A Glance at Some Electrical Features of London.

BY ROBERT M'A. LLOYD.

Americans are very apt to talk as if the commercial history of electricity was being made in this country while the professors and doctors of the old world were still playing with it in their laboratories, and so a glance at the electrical business of London has been a great surprise to those who have crossed the water within the past year. The development of domestic lighting in England has been characterized by strides almost as great as have marked American progress in street railroading; and with this electrical engineering, contracting and the supply business have all enjoyed a considerable boom. While in London a few months ago I was very much impressed with the extent and substantial character of the supply houses, of which there are quite a number. They all appear, not only to be doing a rushing trade, but making money. This is due to the fact that in the residential sections of the city most of the fine houses are being equipped with incandescent lights, and when an Englishman once gets electricity into his house he wants all the frills to go with it, including electric cigar lighters, teapots, laundry irons, footstoves and ventilating fans. One supply dealer told me that within a year he had sold electric heating appliances alone to the value of £5,000.

After seeing in and about London the great number of supply stores, contracting firms and consulting engineers, the next most impressive thing in the electrical line is the number of central stations and the varied character of current distribution.

With the exception of a few arc lights put in service this winter, there is little or no municipal lighting, but there is a great deal of every other kind. The inhabitants spend so little money for heat in that country that they can afford to waste some on light, and they pay almost twice as much for an incandescent lamp as we do in New York in spite of the fact that the price of coal is about the same in both cities.

I visited most of the central stations and learned from the resident engineer of each that his plant was the most economical of all. First there is the great Deptford station on the southeast edge of London, located there to avoid stoppages from injunctions, which are used promiscuously in the metropolis by citizens who object to smoke or noise. Much has been written about this station with its enormous generators and its ten thousand volts. The largest machines are not yet completed, but two of 1,250 h. p. each are running and two of 625 h. p. each. At present these are taking very good care of about 25,000 lights, chiefly from the Charing Cross transformer station, seven miles away, where the potential is reduced from 10,000 to 2,400 volts.

One feature of the Deptford station that I have not seen described before is the method of blowing out the arc at the dynamo switches. These are large manual switches, with a double pole, 4-foot break. While one attendant opens the switch another stands by with an instrument somewhat resembling a canoe paddle, having a flexible leather blade, and with this clubs out the arc. Spark magnets and blowers of every description have been tried, but I was assured by Mr. McLean, the superintendent, that this was the most practicable device so far suggested. Whatever may be said of the wisdom of this stupendous undertaking, the system certainly possesses advantages for London and has met with fair success, notwithstanding a shut down about a year ago to rebuild the transformers at Charing Cross. One of these transformers, by the way, was tried in a tank of oil last summer, but I noticed before leaving England that it had been removed from the station and its failure attributed to impurities in the oil. I am not sure whether subsequent experiments in this direction have been more successful, but, at any rate, the statement that was circulated in the electrical journals a few months ago, to the effect that these transformers were working in oil, was not correct. It is also interesting to note that as yet no one has been killed by these circuits, and that the fall of potential with a 75-ampère load between Deptford and Charing Cross is less than half of one per cent.

Returning from Deptford one feels quite at home on looking in at Lincoln's Inn Fields, where there is a large and complete Westinghouse plant, engines and generators all shipped there direct from Pittsburg and giving perfect satisfaction at 1,000 volts. And this is not the only American apparatus in London, for there are more Crocker-Wheeler motors in use there than all the other small motors put together; not to speak of the lamp sockets, cut-outs and other American manufactures that have gone abroad.

The Westminster station illustrates another system. It is a very complete three-wire installation, with a storage battery regulator, consisting of about 3,000 Crompton-Howell, 500 ampère-hour cells. These cells had been in use about a year, which was the maximum useful life of the positive plates. All the generators in this station are slow speed, driven direct, and have been supplied by several different builders. The most curious of all the London systems is that operated by the Chelsea Electric Supply Company. The central station of this company consists of a generating plant of 500 volts pressure, a few continuous current transformers to reduce the potential for lights in the neighborhood, and a storage battery regulator. There are four distributing stations where storage batteries are charged at 500 volts from the central station and discharged at 100 volts into the service mains.

The distributing stations also have on hand continuous current transformers to aid in carrying the heavy load early in the evening. The storage batteries used are the L type E. P. S. cells, and the positive plates are found to have a useful life in this service of two years. As the sub-stations are regulated from the central station, a description of the paraphernalia at that point would fill an interesting volume. About 1,200 lights are supplied from these batteries, and as both the customers and stockholders are satisfied, I suppose the plan may be considered successful.

There are about 20 central stations in London, and almost every one possesses important features peculiar to itself. In this one city electrical engineers seem to be trying every conceivable method of making steam, driving dynamos and transmitting and distributing electric energy, and I found there a great diversity of opinion as to which methods were giving the best results. It may be interesting, however, to know that so high an authority as Dr. John Hopkinson expresses himself in favor of the three-wire plan. I also asked him what he thought of continuous current transformers, and whether the efficiency of 94 per cent. claimed for them by one of the Elwell-Parker engineers was correct. He said he did not believe a commercial efficiency higher than 88 per cent. possible; and that he considered them too wasteful for electric lighting work in London at any rate.

The lighting companies do not do any inside wiring or sell any fixtures. They merely put on a tap for your house and leave the rest to the contractor, under the supervision of a consulting engineer. In London the consulting engineer asserts himself in a way that is unheard of in New York—in fact it did my heart good to see so many people living on one job.

Outside of the Deptford station the most interesting electrical sight in London is the City & South London Underground Railway. After all there is nothing wonderful about it as a power exhibition except that it is there, and in a land where so little has been done in electric motors. The absence of ventilation in the tunnels is the most conspicuous feature of the entire installation. Mr. Grindle, the resident engineer, explained to me that the air was so bad above ground that there could be no object in introducing it below. A little air does go into the elevator cars when they are opened at the top of the shafts, and walks out with the passengers at the bottom, but any one whose windpipe has not been already seasoned by the steam roads underground can do nothing but gasp while in these electric tubes.

This road, however, certainly demonstrates that electricity is the stuff for underground rapid transit, and that underground roads with ventilation, which is not a serious problem, are a very satisfactory means of getting through big cities. The electrical equipment of the road seemed to be very good, but I was somewhat surprised to find that the engineers did not know how to run compound wound dynamos in parallel. The power is generated by Edison-Hopkinson dynamos built by Mather & Platt, and while the series coils are evenly divided between the two legs of the magnet those on one side only are used, and only used when the machines are running singly. When the machines are paralleled the series coils are all short-circuited, and the potential is regulated by rheostats. As a matter of fact it is exceedingly irregular. The trains are now giving reliable service on this road and the enterprise promises well financially.

The only electric street railway to be seen is that of the East Metropolitan Tramway Company on the Barking road. It is more interesting to an American as a museum than an exhibition. There are six cars operated with E. P. S. accumulators and Immisch motors, but the road has been equipped in a desultory way, and no two of the motors are alike; all sorts of gears are used, and the whole make-up would be called "junk" in this country. The worst grade on the road is four per cent. There are two eight horse power motors on each 16-foot double deck car, and the maximum speed attained on a dead level is eight miles per hour. Each car has two sets of cells of the E type, 96 in each set, which are all charged at night. They make 48 miles per day with each car. The positive plates of the batteries are said to last a year in this service. There is some hope for storage battery traction if the positives can be counted on for such a long period. The road is not at all a discreditable one, when we recall some of our first attempts on this side of the ocean.

Besides the users of electricity, there are so many manufacturers of electrical machinery in London, that I feel that I have indeed only glanced at the subject, but I cannot close this paper without alluding briefly to the electricians themselves. In the first place, there are a great many of them. A meeting of the electrical engineers there will draw together four times as many men as would be gathered by a similar attraction in New York, and they are a very cordial set of gentlemen, especially so to Americans. I found them also quite ready to show me anything which I wanted to see, or to give their views on electrical subjects.

Determination of Electromagnetic Radiation.

An ingenious method has recently been applied by Prof. Klemencic to the determination of electro-magnetic radiation, by means of which he has obtained results agreeing with those of Boys, Briscoe, and Watson, when they used the convection air thermometer. The method used is, according to the *Electrical Review* (London), so different from that employed by these English physicists that a short account may be considered interesting. Essentially Klemencic's method consisted in bringing a thermo-element near a fine platinum wire heated by the electric vibrations, and measuring the increase of temperature at the junction. In order to get comparative results the wire was also heated by a constant current, and the rise of temperature at the junction also measured. In the first series of experiments a form of secondary inductor consisting of two thin brass plates, each 30 centimetres in length and five centimetres in breadth was employed, and the heating of a thin platinum wire two centimetres long was investigated. The investigation showed a production of heat of 0.000155 calorie per second. Another series of experiments was carried out on a single platinum wire 26.0 centimetres long, which was exposed to electromagnetic radiation. This series gave as a value 0.000088 calorie per second. A "Hertz" mirror was used in both these series with a distance of 1.44 metres between the focal lines; the primary conductors corresponded to a wave-length of 66 centimetres; the Ruhmkorff coil was excited by three accumulators and the breaks were at the rate of 23 per second. The value found by Messrs. Boys, Briscoe and Watson works out to 0.000033 calorie per second.

The Philadelphia Theatre Fire Not Caused by Electricity.

The fire in the Central Theatre in Philadelphia has brought to light one of the "half-baked electricians" to which reference was made in our columns a few weeks ago. Prof. Wm. D. Marks, president of the Edison Electric Light Company, of that city, has favored us with a full history of the case by sending us for publication the two reports made by the general agent of that company upon the condition of the wiring in the Central Theatre at the time of and just preceding the disastrous fire. Professor Marks rightly calls attention to the fact that it was only through the vigorous and prompt action of the general agent and of the chief of the electrical department that the company was relieved of all suspicion of having caused the fire.

We append the two reports of Mr. J. T. Maxwell, the general agent, withholding, however, the name of the man whose ignorance and carelessness or something worse led to such dangerous construction. The first report is dated April 27 and is as follows:

I desire to make you acquainted with a piece of work done at the Central Theatre under the supervision of Mr. ——, of the Reliance Electric Company.

On April 18 we received Mr. Gilmore's application for current for one arc lamp to be placed on the balcony, replacing an ordinary calcium light. The wiremen had arranged to place it on 110 volts, which was not in accordance with our rules, and we refused to connect. They applied to you personally, and you confirmed the refusal.

This morning Mr. Hoyte, upon going there to arrange the meter connection, prior to supplying them with current at 220 volts, found that a bridge had been made around the large meter, which has been in position for the past year, and current was flowing on the new wiring without passing through the meter.

Fuses were immediately drawn. Hoyte, after reporting went back and I took Mr. Eglin and followed. On arrival, Hoyte reported that the fuses had been replaced in his absence and he withdrew them again. We saw Mr. Gilmore and reported the case to him, finding that he was entirely innocent. He had given orders to —— not to make any connection at any time, except in the presence of the Edison inspector. Mr. —— being in the building, he was called to the front and made by Gilmore to admit that he had such instruction, and furthermore that he was ordered by Gilmore to put in two lamps in series on 220 volts in order to conform to our rules. Mr. —— tried the current at 220 volts on his lamp through a resistance for 15 minutes after the performance last night, and was experimenting with our current again this morning. He denied making the connection, but would not say who did. Upon questioning others, we found, pretty conclusively, that it was done by his brother, who was working for him.

We examine his resistance, and with startling results. He had run his lines beneath the balcony and had used for resistance a Ward arc lamp, and in series with it and the other lamp he had connected a wire screen which was about 4 feet in height by 7 feet long; this screen was resting on the floor and moreover was tacked to the white pine joists under the balcony. Also in series with these was a long coil of bare iron wire, resting against the joists, without any insulation on screen or wire. Mr. —— had no explanation to make, further than to say that he knew what he was doing and he did not suppose he was doing anything wrong.

I went back to Mr. Gilmore, and stated to him that on examination we found a very dangerous piece of work, upon which we would not allow current to pass. He called for Mr.——, and ordered him to take his lamps and traps of every kind out of the building and not to enter it again.

He thanked us for bringing the matter to his attention so promptly and said he would confer with us shortly about wiring the house, and would have any work in future done entirely under our supervision.

To prevent any further tampering we have closed up our service end.

The second report made by Mr. Maxwell is dated April 28, and is as follows:

To complete the history of the Central Theatre, which was commenced in my report of yesterday, I wish to add that the interview with Mr. Gilmore mentioned therein occurred at 10:30 A. M.

Our property, including meter, had been removed and service end closed up at 12:30 P. M. The dangerous work referred to was at the Walnut street side of the building, under the balcony. No wires passed from the front of the house to the stage.

The fire of last night broke out shortly before 8 o'clock on the stage. The threatened fire was from electric current at the south end of the house. The actual fire was from gas at the north end,

Corrections of Wattmeter Readings.

BY ROBERT M. FRIESE.

In THE ELECTRICAL WORLD of March 5, page 153, Mr. Danielson published an article on "Precautions to be Observed in Applying Corrections to Wattmeter Readings," in which he points out that under certain circumstances an error may be introduced by using the correction formula :

$$\frac{1+\lambda_2^2}{1+\lambda_1\lambda_2}$$

The reason for this appears to be that in this correction formula the lagging of the phases is included in L_1 and L_2, but the equation does not take into account the lagging produced by Foucault currents and hysteresis. This formula, moreover, could not take into account these corrections.

Stefan* was the first to calculate this correction formula in the year 1883, at the time when the results obtained by Warburg, 1881, and Ewing, 1882, regarding the hysteresis experiments, had an interest only for physicists, and were only just beginning to be known. Of the action of hysteresis in transformers nothing, of course, could be said at that time, as the first practical application of the transformer of Goulard and Gibbs† was only just introduced in that year.

It was not until 1887 that Ferraris developed the theory and showed the practical application of phase differences caused by Foucault currents and hysteresis. The theories of transformers based on this are all of later date. In order to be able to determine this correction factor theoretically, we must be allowed to make some supposition and to be able to neglect some quantities, among which hysteresis and Foucault currents are not the only ones, and which we mention here as follows. The correction formula in the form given above supposes sinusoidal alternating currents, as Mr. Danielson has already stated ; but this condition, as is well known, is often not fulfilled, and therefore, in this respect, already an error is introduced into the result. Besides this, the formula is furthermore developed under the assumption that the fine winding of the wattmeter has no other electromotive forces in it than those of self-induction, and that, therefore, the other circuits do not act on it inductively ; it is furthermore assumed that the static capacity of the circuit may be neglected, and that L_2 is constant; that is, that the fine wire circuit (the movable coil) does not change its shape and does not contain iron. Those last conditions can be met perfectly and without doubt ; the compensation of the deflection of the movable spool by torsional springs at the moment of taking the reading can be made sufficiently exact that the two coils may be considered perpendicular to each other, so that an induction between the stationary coil and the movable coil takes place only by negligibly small amounts. In how far an error caused by neglecting the capacity will affect the result I would not venture to say.

The system of connections which was chosen for the test with the wattmeter also contains errors under certain conditions. In one case the wattmeter is connected so that the main current coil is connected in the branch in which the watts are to be measured, they are thereby connected within the points to which the potential circuit is connected. In this case the energy lost in the main current winding will be included in the measurement. This winding, however, generally consists of a few turns of thick wire, and one can therefore neglect the energy lost in it. On the other hand the wattmeter may also be connected so that the main current coil is outside of the points to which the shunt wires are attached. In this case the current C in the main coil is equal to the algebraic sum of the current C_1 in the circuit to be measured, and c, the current in the shunt winding of the wattmeter. Now, the phase difference between c and the E. M. F. depends on L_2 and the phase difference between C_1 and the E. M. F. depends on L_1, hysteresis, and Foucault currents. c and C_1 therefore have a phase difference between them, and may be combined by means of a parallelogram of forces, to C; it follows therefore that C_1 and C have a phase difference between them. As c must always be taken small as compared with C_1, so in the same way C will differ but little in its amplitude from C_1, and therefore the phase difference between C and C will also be small. One can neglect a small phase difference and therefore make C_1 equal to C. In both cases errors will be made which, however, one should always examine, as they may under certain circumstances affect the result much more than one at first believes.

Even though the correction formula of Stefan given above is deduced under certain conditions, and though it does not include several sources of error, and therefore should be used only with great care, it nevertheless is of great importance. It shows us that the indications of the wattmeter give correct results in two cases, that is, in those cases no correction is necessary. The conditions in those cases are that this formula be made equal to 1. This condition is met when $\lambda_1 = \lambda_2$, that is when the time constants $\frac{L}{r}$ of both the circuits are equal to each other, or when the phase difference between c and the E. M. F. is equal to the phase difference between C and the E. M. F. This condition is of no value in practice, as the time constant $\frac{L_2}{r_2}$ of the potential winding can always be given for a given value of r_2, which is, however, not the case for the main current circuit. The value of the correction factor will, however, also be equal to 1 when $\lambda_2 = 0$, that is, when there is no phase difference between c and the E. M. F. This is the case which is important in practice. As $\lambda_2 = \frac{2\pi n L_2}{r_2}$, this will become zero, when $L_2 = 0$ (or $r = \infty$, which in practice is of no value). If it were really possible to make $\lambda_2 = 0$, then the wattmeter would be very nearly an ideal instrument, and its readings would be correct no matter what phase difference exists in the current whose watts are to be measured; it would also be independent of their source, for we then make use of the simple property of the electrodynamometer by which the deflection is proportional to the product of the mean values of the product of the two currents C and c in the windings, with the cosine of their phase difference; as c then no longer has a phase difference with the E. M. F. E, we will have the following condition in the indications of such a wattmeter: the energy $A = C\,E\cos\varphi$.

The self-induction of the potential circuit may moreover be made practically zero if a certain capacity in the form of a condenser is introduced in the shunt circuit of the wattmeter. The self-induction equals $E_1 = 2\,\pi\,n\,L_2\,c$; the counter E. M. F. of the capacity equals $E_2 = \frac{c\,10^6}{2\,\pi\,n\,K}$, in which E_1 and E_2 are in volts, L_2 in henrys and K in microfarads. If these two expressions are equated we will obtain for the value of the capacity $K = \frac{10^6}{(2\,\pi\,n)^2 L_2}$ microfarads. In order not to have too large values for K, L_2 should be chosen as large as possible, for instance, by not making the external resistances which reduce the current c, and which always exist in the shunt circuit, bifilar, and by winding the movable spools with many turns, by which one also obtains a much higher sensitiveness. The use of iron for increasing L_2 is of course excluded. As will be seen from the equation for K the potential circuit will in this way be free of induction only for a particular frequency, and for every other frequency there would have to be a different capacity inserted. But as each company which makes alternating current apparatus usually adopts a fixed frequency for which the apparatus is adjusted, the above suggested arrangement of using a particular capacity can always be used as a correct means of measurement, and does not necessitate the introduction of any corrections. This is of importance to the scientist, but it is especially so for the engineer, as the efficiency of alternating current apparatus can be found only with the wattmeter, because separate measurements of current and potential are completely useless whenever there is the slightest phase difference. If complicated corrections must be made with the results obtained, for the determination of which another special series of measurements are necessary, the accuracy of the final results will naturally suffer considerably, and the application of the wattmeter will then be almost useless. The same manner of looking at this problem has also shown that the factor λ_2 should at least be practically zero in order that the time constant $\frac{L_2}{r_2}$ of the potential circuit may be made as small as possible. L_2 should be made as small as possible and r_2 as large as possible. The first requires that there be as few turns as possible on the moving spool in the shunt circuit. By doing this the whole method of suspension becomes easier and allows very fine suspension wires to be used; this enables one, at least partially, to compensate for the diminution of the sensitiveness produced by the reduction of the number of turns. The second requires that the external resistance be as high as possible and without induction, by which c will at the same time have a very small value. The newer forms of wattmeter show considerable improvement in this respect over the older forms.

The example given by Mr. Danielson, taken from Kittler's book, refers to a wattmeter of the old form, with a self-induction coefficient of .0015 energy in the shunt winding and an external resistance of 20,000 ohms. In the newer instruments, which are in use in the laboratory of Professor Kittler, $L_2 = .0007$ and the sensitiveness of the instruments enables the external resistance to be made 25,000 ohms. From this data the example referred to above gives $\lambda_2 = \frac{2\,\pi\,42.5 \times .0007}{25{,}000} = .00000748$, and the correction factor then becomes .992 instead of the approximate value .99, which is calculated for a phase difference of 73 degrees 57 minutes, which is correct for a 19 per cent. difference in periodicity. It follows from this that in the most unfavorable cases a correction of .8 per cent. becomes necessary, which can be neglected.

This may be neglected especially because most of the modern alternate current apparatus contain iron, which, as we know, is a source of a certain loss of energy caused by hysteresis and Foucault currents. As the self-induction in the circuit of the wattmeter tends to increase the phase difference between the impressed E. M. F. and the useful current, hysteresis and Foucault currents will tend to diminish the phase difference between these two values. As the first factor λ_1 of the correction factor represents only the first phase difference, it follows that it must always have values which are too high when hysteresis and Foucault currents exist; or, in other words, the correct λ_1 in the latter case (which is the most frequently occurring one in practice) is always smaller than the value of λ_1 calculated from $\frac{2\pi n L_1}{r_1}$. It follows, therefore, that the value of the correction factor given at the beginning of this article must always be nearly unity. For this reason corrections of the wattmeter readings may in general be omitted, provided that the shunt winding meets the conditions given above as well as possible. That these conditions can be complied with very closely in modern wattmeters (especially when readings are taken with the mirror in order to get exact results) has already been explained. The results, however, will be quite different when the wattmeter does not comply with these requirements. Mr. Danielson has given such a case, from which it will be seen that owing to the hysteresis and Foucault currents the measured watts differ from the true watts only about six per cent., while the corrected watts obtained by neglecting the hysteresis and Foucault currents, only under the assumption of the self-induction correction of the watts, differ from the true watts about 60 per cent.

According to my views such a wattmeter with which these results were obtained is not at all suited for alternating current measurements as its readings cannot be applied directly, but only after cumbersome corrections, for which separate current, potential and resistance measurements, etc., are required. But there is just this particular advantage of the wattmeter, namely, when correctly constructed it enables one to make measurements readily and very quickly and without corrections; in this property of an alt ternating current energy measuring instrument, it has nobeen exceeded by any of the various other proposed methods. If one would use the wattmeter above described in place of the one used by Mr. Danielson, its readings could be taken directly without corrections, as its sensitiveness in the example in question allows for the introduction of 1,000 ohms in the shunt circuit, and for the value $L_2 = .0007$, the correction, as can readily be proved by calculation, would then be only .7 per cent.

If one is, notwithstanding, compelled to use a wattmeter which does not meet these requirements one can, as Mr. Danielson states, obtain the probable value of the phase difference φ_1 in the main circuit (even though it is not simple), for which, however, separate measurements of currents and potential are required, besides the knowledge of the resistance, self-induction coefficient, of the shunt winding, and the frequency.

The value of φ is given from the following equation :

$$\tan\frac{\varphi_1}{2} = \frac{\lambda_2 + \sqrt{1+\lambda_2^2 - X^2}}{1+X}$$

in which $\lambda_2 = \frac{2\,\pi\,n\,L_2}{r_2}$ and $X = \frac{W(1+\lambda_2^2)}{A\,V}$.

A = the current in the main circuit in ampères ;
V = the potential in the main circuit in volts ;
n = the frequency ;
L_2 = the self-induction coefficient of the shunt winding of the wattmeter ;
r = the resistance of the same ;
W = equals the watts as indicated by the readings.

This expression was obtained by equating the following equations of condition :

$$\text{True work} = A\,V\cos\varphi_1 \qquad (1)$$

$$\text{“ “} = W\frac{1+\lambda_2^2}{1+\tan\varphi_1\,\lambda_2} \qquad (2)$$

By solving this trigonometric equation for φ_1 the formula given above is obtained for $\tan\frac{\varphi_1}{2}$. From this known phase difference φ_1 one can then obtain the true watts from equation (1) by introducing the values, of A V and φ_1.

It is readily seen that for every value of the watts as read a correction of this sort is necessary. As the calculation of this correction is deduced and requires time, the engineer will surely prefer to work with a wattmeter which makes these corrections unnecessary by virtue of its construction.

* Official report of the International Electrical Exhibition of Vienna, 1883.

† Exhibited as experimental apparatus in the Aquarium at London, 1888.

Electric Street Railways.

Mr. A. M. Young, secretary of the Connecticut Electric Company, of Waterbury, Conn., recently returned from a business trip to the South, and in an interview in the Waterbury *Republican*, regarding his intentions concerning the Waterbury Horse Railroad Company, a controlling interest in which has recently passed into his hands, does not make any secret of his opinion that electricity is the most desirable motive power for street railways in every sense of the word ; and while not avowing his intention of immediately equipping the Waterbury system electrically, he stated that in time such a change would probably be made. "I intend,' he said, "to devote a great deal of my time from now on to make the Waterbury street railway more popular than ever and to give its patrons safe and rapid service. There are in the country to-day over 500 cities where street railways are run by electricity in a manner satisfactory to both the public and the companies interested, and contracts to equip roads in over 200 other cities are now on. With elec tricity as the motive power, and under the high state of perfection to which such a system has now been brought, cars can be run with scarcely any noise, with perfect safety and much more rapidly if desired. There are no irritating jars when a car stops or moves again, and it is all the same up hill or down or on the level. It is what all cities of any size are coming to."

The Weston Voltmeter as a Testing Instrument.

BY E. A. MERRILL.

In many electric light and power installations it is absolutely necessary that current shall be on the line at all hours of the day and night throughout the year, and that any interruption to any branch shall be for the least possible time. This necessitates a method of insulation testing which admits of application with the system in operation, and which shall not interrupt the service at any point for an appreciable time. Moreover, it is advisable in all installations to make accurate tests of the condition of the system, as regards insulation, while in operation, whether the operation be continuous or not, for tests, whether on main or branch circuits, made with the ordinary pressure

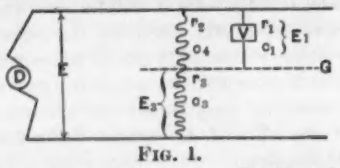


FIG. 1.

to which the system is subjected, will often show up faults which the bridge method with a few cells of battery will not locate.

For such testing I know of no instrument which lends itself so readily to various conditions and requirements as the ordinary Weston voltmeter. Its accuracy within the range of practical work is certainly very near, if not quite equal to, the average bridge set used for the same purpose. Therefore, in view of the interest which attaches to the instructive articles by Dr. Maschke, I venture to supplement his articles by illustrating further applications to testing which occur in actual practice. In order to bring

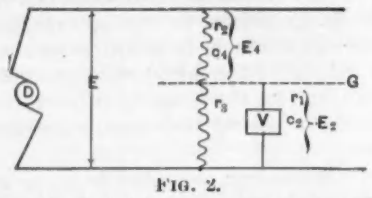


FIG. 2.

those points of special interest to the practical station superintendent within the limits of a single article, I repeat some of Dr. Maschke's formulas in slightly different form, and amplify others.

Among others, the use of the Weston voltmeter has the following advantages over that of the bridge method:

1. The test can be made at the regular working pressure.
2. The E. M. F. of supply at each point can be taken by the same instrument.
3. The instrument is dead beat and gives instantly the correct reading, thus obviating the necessity of plugging and unplugging to obtain a balance.
4. It can be used in dark places with the aid of an incandescent lamp where other methods of illumination would be dangerous.
5. The readings can be made rapidly, thus saving time and with a minimum interruption of service.
6. A much less responsible man is required since but

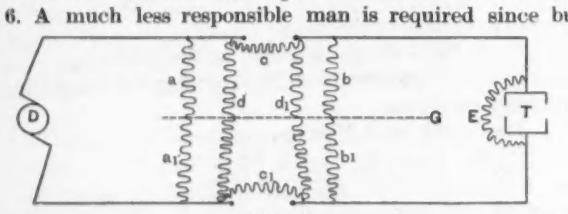


FIG. 3.

one reading is taken at a time, and the method admits of routine in its application.

The following examples will illustrate its use. Other applications will suggest themselves to the practical station superintendent:

1. *General insulation test of lines from ground.* (Fig. 1.)

D = dynamo or other source of supply.
E = E. M. F. of system.
G = ground.
r_1 = resistance of voltmeter V.
C_1 = current through V.
E_1 = E. M. by V when connected from line to ground.
r_2 = insulation resistance to ground throughout system on one side.
C_4 = current through r_2.

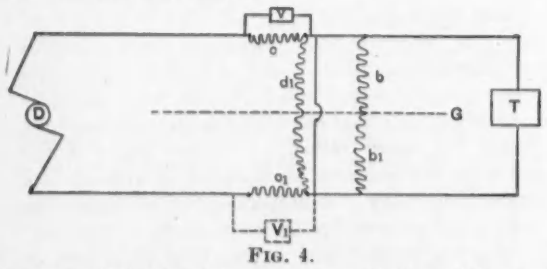


FIG. 4.

r_3 = insulation resistance to ground throughout system on other side.
C_3 = current through r_3.
$E_3 = E - E_1$.

$$C_2 = \frac{E_2}{r_2} = C_1 + C_4 \quad . \quad C_1 = \frac{E_1}{r_1} \quad . \quad C_4 = \frac{E_1}{r_2}$$

$$\frac{E_2}{r_2} = \frac{E_1}{r_1} + \frac{E_1}{r_2}$$

$$r_2 = \frac{E_2}{E_1} \cdot \frac{r_1 r_2}{r_1 + r_2} \qquad (1)$$

If r_2 is very large in comparison with r_1, then $\frac{r_2}{r_1 + r_2}$ will not differ sensibly from unity, and (1) may be written

$$r_2 = r_1 \frac{E_2}{E_1} \qquad (2)$$

in which r_1 is the resistance of the voltmeter and therefore constant, E_1 the observed deflection of V, $E_1 + E_2 = E$, the E. M. F. of the circuit.

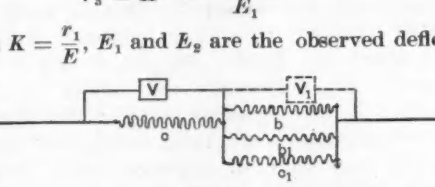


FIG. 5.

Now connect the voltmeter to the other side. (Fig. 2.) As before we have:

$$r_2 = \frac{E_4}{E_2} \cdot \frac{r_1 r_3}{r_1 + r_3}, \qquad (3)$$

and when $\frac{r_3}{r_1 + r_3}$ does not differ sensibly from unity:

$$r_2 = r_1 \frac{E_4}{E_2} \qquad (4)$$

If $\frac{r_2}{r_1 + r_2}$ and $\frac{r_3}{r_1 + r_3}$ cannot be neglected, we may as-

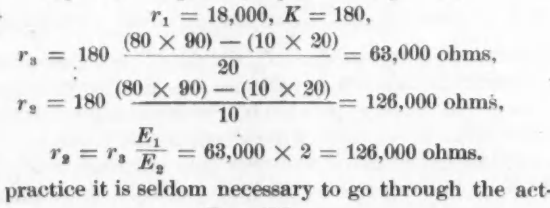


FIG. 6.

certain the exact values of r_2 and r_3 as follows: In equation (1) substitute the value of r_3 in equation (3). Whence:

$$r_2 = \frac{\frac{E_2 r_1 \cdot \frac{E_4 r_1 r_3}{E_2 (r_1 + r_3)}}{E_1 r_1 + \frac{E_4 r_1 r_3}{E_2 (r_1 + r_3)}}}{} = \frac{r_1}{E_1} \cdot \frac{E_3 E_4 - E_1 E_2}{E_2 + E_4}$$

In this equation it will be observed that r_1, the voltmeter resistance, is constant for a given instrument, and that $E_2 + E_4 = E$, which may be considered constant for a given circuit unless the drop is excessive. The equation then reduces to:

$$r_3 = K \frac{E_3 E_4 - E_1 E_2}{E_1} \qquad (5)$$

in which $K = \frac{r_1}{E}$, E_1 and E_2 are the observed deflections,

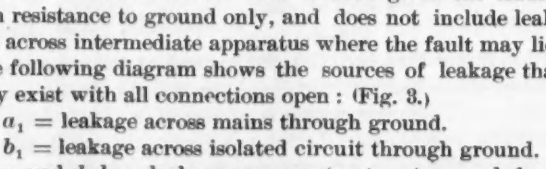


FIG. 7.

E_3 and E_4 the differences between the E. M. F. of the circuit and the observed deflections. By a similar process

$$r_2 = K \frac{E_3 E_4 - E_1 E_2}{E_2} \qquad (6)$$

Equations (2), (4), (5) and (6) are the only ones necessary to use. It may further be observed that the resistances are proportional to the deflections:

$$r_3 : r_2 : : E_2 : E_1 \qquad (7)$$

Example:

$$E = 100, E_1 = 20 \quad E_2 = 10,$$
$$E_3 = E - E_1 = 80, E_4 = E - E_2 = 90.$$
$$r_1 = 18{,}000, K = 180,$$
$$r_3 = 180 \frac{(80 \times 90) - (10 \times 20)}{20} = 63{,}000 \text{ ohms},$$
$$r_2 = 180 \frac{(80 \times 90) - (10 \times 20)}{10} = 126{,}000 \text{ ohms},$$

or: $$r_2 = r_3 \frac{E_1}{E_2} = 63{,}000 \times 2 = 126{,}000 \text{ ohms}.$$

In practice it is seldom necessary to go through the act-

FIG. 8.

ual computations, but for a given number and class of circuits a deflection can be predetermined, above which the circuit shall be considered faulty and below shall be passed or between certain limits may be marked "doubtful."

2. *Insulation test of circuit to ground, and for leakage across translating devices, switches, cut-outs, etc.*

It is evident that the first method gives the insulation resistance to ground only, and does not include leakage across intermediate apparatus where the fault may lie. The following diagram shows the sources of leakage that may exist with all connections open: (Fig. 3.)

$a a_1$ = leakage across mains through ground.
$b b_1$ = leakage across isolated circuit through ground.
$c c_1$ and $d d_1$ = leakage across cut-out, not grounded.
e = leakage across translating device, not grounded.
T = translating device.
G = ground.

Case A.—Insulation resistance of c c_1 (cut-out) across fuse terminals. (Fig. 4.)

To eliminate d_1 and b b_1 the translating device T may be closed or short-circuited as indicated. With readings at V and V_1 the resistances of c and c_1 may be ascertained by formulas (5) and (6).

Case B.—Insulation resistance from + to — when both terminals are on the same base. Branch disconnected but fuses in. (Fig. 5.)

$d d_1$ = leakage across cut-out, not grounded.
$f f_1$ = fuses.
c = current through V.
r_1 = resistance V.
r_2 = insulation resistance across cut-out at $d d_1$.
E = E. M. F. of circuit.
E_1 = observed deflection.

$$c = \frac{E}{r_1 + r_2} = \frac{E_1}{r_1}$$
$$r_2 = r_1 \frac{E - E_1}{E_1} \qquad (8)$$

This is the same as formula (2).

Case C.—Insulation resistance to ground. (Fig. 6.)

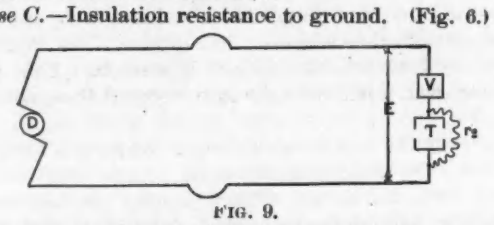


FIG. 9.

L = lamp to ground. It is always advisable to ground through a lamp or equivalent resistance on the live section to avoid excessive currents in case there is a heavy ground on the side not artificially grounded or in case of an accidental short-circuit to ground. The resistance of a lamp, and in general of a translating device, does not introduce sensible error under ordinary conditions. As in case A the translating device may be closed or short-circuited at the cut-out.

The above is equivalent to: (Fig. 7.)

b, b_1, C_1,

Since, by Case A, c is known the combined resistance of $b b_1 c_1$, may be ascertained from the proportion r_c : E_c : : $r_{b\ b_1\ c_1}$: $E_{b\ b_1\ c_1}$, [see (7)], in which r_c is the resistance across c, E_c and $E_{b\ b_1\ c_1}$, the observed deflections; since, by case A, c_1 is known the combined resistance of

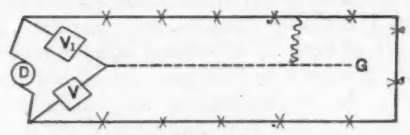


FIG. 10.

$b b_1$ may be ascertained and the average value of b and b_1 will be double their combined value.

If, as is usually the case, the translating device can be cut out on one or both sides, or if when open the insulation resistance across its terminals is several megohms, and the circuit can be disconnected from the cut-out, the voltmeter can be inserted in series with the ground and the operation becomes much simplified; by this method b and b_1 are determined separately. The diagram, Fig. 8, gives the connections for ascertaining b, for b_1 they are simply reversed. For formula see (8).

Case D.—Insulation resistance of translating device across terminals.

The voltmeter is simply connected in series with the open translating device. (Fig. 9.) Formula (8).

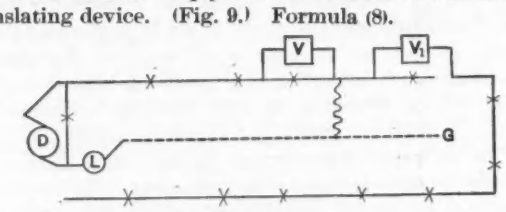


FIG. 11.

3. *Testing arc circuits.*

Case A.—Testing for ground. Fig. (10.)

Connect voltmeter first at V and then at V_1. If the ground is a heavy one the ratio of the deflections will locate the ground quite closely, and in any event the ratio of the deflections will give the ratio of the lamps on each side from the apparent location of the ground to the actual. For example, suppose $V = 100$, $V_1 = 200$, then the apparent location of the ground, allowing 50 volts per lamp, is two lamps from the station on one side and four lamps on the other, with six lamps between; the actual ground will divide these six lamps in the proportion of 1: 2, and is, therefore, 2 + 2 lamps from the station on one side and 4 + 4 lamps on the other. This is, of course, subject to variation in case there is more than one ground, or the general insulation of the system is low.

Case B.—To locate the ground. (Fig. 11.)

The dynamo circuit is closed on one or two lamps at the station, one side is connected to the line and the other to ground through a resistance, say an incandescent lamp, in order to prevent an excessive current through the ground.

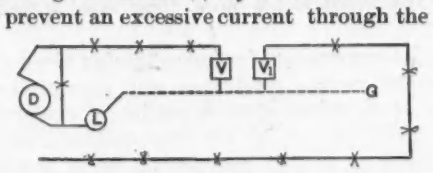


FIG. 12.

The line is then opened at any convenient point and the voltmeter inserted. If on the station side of the ground there will be a certain deflection, if beyond the ground there will be no deflection, or at least a much smaller one. The ground having been cleared the station can be signalled by means of the incandescent lamp in the ground circuit.

Case C.—To locate an open circuit. (Fig. 12.)

The station connections and method are as in case B, except that the line is not opened. At V there will be a deflection, at V_1 none, or a much smaller one. As in case B, the station may be signaled by means of the incandescent lamp when the circuit is closed.

Case D.—To measure the insulation resistance to ground.

In Fig. 13 r_2 represents the insulation resistance throughout the system.

r_1 = resistance of voltmeter.

E = E. M. F. across dynamo terminals.

E_1 = voltmeter deflection.

$$r_2 = r_1 \frac{E - E_1}{E} \quad \text{[see (8)]}$$

In this case the circuit on which the dynamo is closed should be of constant resistance, such as a group of incandescent lamps, in order that E may be accurately known.

In cases B, C and D it is not necessary to operate the dynamo ordinarily connected to the given circuit, but any dynamo, arc or incandescent can be used.

While some of the formulas given above may seem tedious to work out on a large system it will not be found so in practice when they are separated from explanatory equations, and the operation has been reduced to a sys-

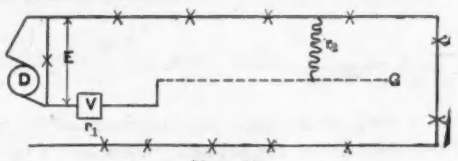


FIG. 13.

tematic order, especially when it is remembered that in the majority of cases the work can be reduced simply to a question of the allowable deflection for a given circuit.

Some very instructive experiments may be made by connecting a voltmeter to the terminals of a faulty lamp provided with a broken globe, or no globe, and suspended freely outside the station; the fluctuations in voltage due to long arcs drawn out in a stiff breeze, irregular feed from swaying, jarring or uncleaned working parts, varying connection with line wire at terminals from the swaying and twisting of the lamp, and even the terminal voltage when the lamp is cut out will furnish much valuable information as to methods necessary for the attainment of high operating economy.

On a 125-volt circuit with a voltmeter reading to 150 volts an insulation resistance of two megohms can be read very accurately, while a close approximation can be made to four megohms.

On the Retardation Due to Iron Pipes.*

BY W. H. PREECE, F. R. S.

About three years ago, when the working of the electric light installation at the Holborn Restaurant was changed from an isolated plant to the central station system of the Metropolitan Electric Supply Company, a considerable fall of potential was observed when alternating replaced the continuous currents. This was traced to the choking effect of some iron-cased conductors which were used as service leads. It was easily cured by placing the go and return leads in the same iron casing. Particulars of this experience were not published. A similar effect occurred recently when the City of London Electric Light Company supplied current to Messrs. Mappin & Webb's establishment opposite the Mansion House. Major-General Webber has been kind enough to supply me with full particulars of this experience,† and as the effects were traceable to causes which Prof. Ewing had been investigating, and of which he was such a master, I submitted them to him, with the result that he has sent me the following very interesting letter:

"The fall of potential observed by General Webber in alternate current service wires when these are laid in separate iron pipes is rather a complicated matter. It admits, however, of tolerably complete analysis by help of the equations lately published by J. J. Thomson (*The Electrician*, April 8), some of the uses of which were exemplified in a subsequent paper of mine (*The Electrician*, April 15).

"Apart from the small drop which is caused by the ohmic resistance of the conductors, there are three things that contribute, as consequences of the sheathing pipes, to bring down the volts at the distant end of the service wires:

"(1) First, there is the self-induction of the conductors. The presence of the iron pipes, of course, enormously increases the self-induction, making the cables in the pipes act like choking coils, and reducing the power supplied to the circuit by making the current in them lag behind the E. M. F. in the mains. In other words, the pipes give rise to an E. M. F. of self-induction which opposes the impressed E. M. F. of the supply. This is one reason why the E. M. F. measured between points beyond the sheathed part of the service lines is less than the original E. M. F. The fall of E. M. F. due to this cause does not in itself imply a waste of energy; it only means that less energy is taken from the mains.

*From *The Electrician*, London.

†Particulars supplied by Major-General C. E. Webber:

Alternations, 100 complete periods per second; size of conductor, 19 strands of No. 14, .0973 square inch section; insulations, Class K Silvertown over all diameter 0.71 inch; length of cables, 51 feet between the two testing points, making 102 feet in circuit; calculated copper resistance at 60 degrees Fahr 0.00884 ohm. Each cable was placed in a separate pipe. Internal diameter of pipe, 1.25 inches; external diameter of pipe, 1.65 inches; length of pipe, 43 feet in two pieces on each cable; total length of pipe, 86 feet, in four pieces.

The following tests were made:

Drop between ends of line. Volts.	Load in 60-watt (16-c. p.) lamps at 100 volts.	Drop between ends of line. Volts.	Load in 60-watt (16-c. p. lamps at 100) volts.
0	0	11	100
2	12	13	140
8	43	12	140

The two voltmeters used were checked together and found to fairly agree, but owing to the fluctuation of the current at the time no accurate readings could be taken.

"(2.) Next, there is the loss due to eddy currents in the pipe. The alternate circular magnetization of the pipe sets up eddy currents in it, and the power which is wasted in these requires that there should be a fall in the voltage on their account.

"(3.) Then, lastly, there is the loss due to magnetic hysteresis in the pipe. This again wastes energy, and requires a further fall in the voltage.

"The three effects may be calculated separately. In calculating the self-induction and the loss due to hysteresis, it has to be borne in mind that the distribution of magnetism is by no means uniform throughout the substance of the iron. With a pipe so thick as the one described by General Webber there is much magnetic screening. The eddy currents prevent the magnetic force from penetrating into the interior of the metal with anything like the intensity which the force has at the skin. J. J. Thomson's expression for the force (H_x) at any distance x from the middle of the thickness of the pipe may be written

$$\mathsf{H}_x = \mathsf{H}_0 \left(\frac{\cosh 2\,m\,x + \cos 2\,m\,x}{\cosh 2\,m\,a + \cos 2\,m\,a} \right)^{\frac{1}{2}},$$

where H_0 is the force at the skin, a is the half thickness of the pipe, and m is the quantity $2\,\pi \sqrt{\frac{\mu\, n}{\sigma}}$, μ being the magnetic permeability, n the frequency of the alternations, and σ the specific electric resistance of the iron. From measurements and tests of the sample of pipe which you sent here I find that μ is 1,000 and m (with a frequency of 100) is close upon 20. At the middle of the thickness the magnetic force has barely one-thirtieth of its skin value. The mean magnetization of the pipe is only about one-sixth of what it would be if a steady current were maintained in the conductor with strength equal to the maximum strength of the alternating current. The mean magnetic induction in the pipe, to be used in calculating the self-induction of the conductor, is

$$\frac{\mu\, \mathsf{H}_0}{m\,a\,\sqrt{2}} \left(\frac{\cosh 2\,m\,a - \cos 2\,m\,a}{\cosh 2\,m\,a + \cos 2\,m\,a} \right)^{\frac{1}{2}},$$

which, in the case considered, is sensibly equal to $\frac{\mu\, \mathsf{H}_0}{m\,a\,\sqrt{2}}$.

"Next, to calculate the eddy current waste, the rate of dissipation of energy in eddies, per cubic centimetre of the pipe, in ergs per second, is

$$E = \frac{\mathsf{H}_0{}^2\, m\, \sigma}{32\, \pi^2\, a}$$

multiplied by a coefficient, which in the case we are dealing with is sensibly equal to unity.

"To find the loss due to hysteresis, we must first obtain by magnetic tests a set of values of $f\, \mathsf{H}\, d\, \mathsf{I}$ for cycles of magnetization, using various amplitudes of magnetizing force. Then, by the expression given above for H_x, find the value which the magnetic force reaches at various depths within the metal, and so proceed to determine a proper mean of $f\, \mathsf{H}\, d\, \mathsf{I}$ for the whole of the iron.

"When all this is done the total drop in volts which the iron pipe sheathing may be expected to cause will be found by adding the losses due to these three more or less independent actions.

"I have determined the magnetic constants of the pipe you sent and have made a calculation of the several effects which, although somewhat rough, is sufficient to show that the sum of the losses is at least of the same order of magnitude as the drop which General Webber observed. It is not, I think, worth while to pursue the calculation further, for the data of the case are scarcely precise enough to make the observation serve well as a test of the theoretical work. The observation is, however, very interesting, not only on the practical side as showing forcibly the necessity of putting both conductors into one pipe, when iron pipes are used to protect alternate current mains and service wires, but also as giving material for the application of the equations which were published by J. J. Thomson only a week ago. It is a case in which the influence of eddy currents in screening the interior of the iron is so great that any calculation in which consideration of that influence was omitted would quite fail to give even roughly correct results. The eddy currents are in themselves a source of loss, but indirectly they reduce the total loss by protecting the inner parts of the metal from magnetization. Were it not for this protection the drop in volts due to hysteresial dissipation alone would be greater than the whole drop that was actually observed."

The point that interested me particularly in this inquiry was the effect which this choking influence would have on retarding telegraphic signals and in deteriorating telephone speaking. In long submarine cables the iron sheathing has apparently no retarding effect on the transmission of signals, and this is due probably to its want of circumferential continuity; but with iron piping the form and the effect are different. Here induction and hysteresis will retard the currents and will increase the sum of opposing effects which limit the rate of working. There is a tendency to put wires in iron pipes underground to secure safety from wind and snow; but unfortunately this is done at the expense of effectiveness. Long lines of iron piping will probably be death to fast speed telegraphy. Of course, in telephony iron piping is seriously detrimental to single wire working, but then no one would dream of using any but the metallic circuit system in any underground work.

There is another point for consideration, and that is, may not wood or earthenware or cement replace iron as a conduit for electrical conductors, and be made equally effective from the mechanical economical point of view?

The Elementary Principles Necessary to Establish the Equation of Electromotive Forces for a Circuit Containing Resistance and Self-Induction.—II.*

BY FREDERICK BEDELL AND ALBERT C. CREHORE.

Circuits Containing Resistance and Self-Induction.—In the first paper was derived the equation for the energy in a circuit containing self-induction and resistance.

The equation of energy is

$$e\, i\, dt = R\, i^2\, dt + L\, i \frac{di}{dt}\, dt \qquad (1)$$

that is, the total energy given to the circuit is equal to the sum of the energy transformed into heat and the energy expended in setting up the field.

From the equation of energy was derived the equation of electromotive forces

$$E = R\, i + L \frac{di}{dt} \qquad (2)$$

that is, the electromotiveforce applied to the circuit is equal to the sum of the electromotive force necessary to overcome resistance and the electromotive force necessary to overcome the counter electromotive force of self-induction.

This equation of electromotive forces (2), being regarded as a differential equation containing three variables e, i and t (of which the general type of the first order is:

$$P\, dx + Q\, dy + S\, dz = 0 \qquad (3)$$

where P, Q and S are any functions of x, y and z) does not satisfy the condition of integrability. The condition which must hold true when there exists a single integral equation of which (3) is the exact differential is:

$$P\left(\frac{dQ}{dz} - \frac{dS}{dy}\right) + Q\left(\frac{dS}{dx} - \frac{dP}{dz}\right) + S\left(\frac{dP}{dy} - \frac{dQ}{dx}\right) = 0$$

If we put (2) in the form of (3) we have

$$0\, de - L\, di + (e - R\, i)\, dt = 0 \qquad (4)$$

Here e, i and t correspond to x, y and z respectively, and $P = 0$, $Q = -L$, $R = e - R\, i$.

The criterion of integrability reduces to

$$-L(1 - 0) = 0, \text{ or } -L = 0 \qquad (5)$$

and is not satisfied.

The meaning of this is that, unless some relation exists between two or more of the variables, there is no single equation of which (2) is the exact differential.

We know that the impressed E. M. F. e has one single value at a particular point of time, and may therefore be expressed as a function of the time thus,

$$e = f(t) \qquad (6)$$

where f is any arbitrary single valued function.

Upon substitution in (2) the equation of E. M. Fs. is reduced to a linear equation, having constant coefficients with the second member equal to $\frac{f(t)}{L}$. Thus

$$\frac{di}{dt} + \frac{R}{L}\, i = \frac{1}{L} f(t). \qquad (7)$$

The general type of this equation is

$$\frac{dy}{dx} + P\, y = Q \qquad (8)$$

where P and Q may be functions of x only. The solution of equation (8) which is called a linear differential equation, may be found in any ordinary treatise on differential equations, and is

$$Y = \varepsilon^{-\int P\, dx} \int \varepsilon^{+\int P\, dx} Q\, dx + c\, \varepsilon^{-\int P\, dx}$$

ε denotes the base of the Napierian system of logarithms and is equal to 2.718. c is the arbitrary constant of integration. Both of these letters will be used with these significations whenever they occur.

With the particular values of the coefficients in (7) its solution is therefore,

$$i = \frac{\varepsilon^{-\frac{Rt}{L}}}{L} \int \varepsilon^{\frac{Rt}{L}} f(t)\, dt + c\, \varepsilon^{-\frac{Rt}{L}} \qquad (9)$$

The integration indicated in (9) can only be performed when we assume ε to be some particular function of t. We proceed then to assume several ways in which the E. M. F. varies with the time.

Case I. Dying Away of Current on Removal of E. M. F. from a Circuit Containing Resistance and Self-Induction.—Suppose that a current has been flowing in a circuit until it has reached its steady state, and that the source of E. M. F. is then suddenly removed while the resistance and self-induction remain the same. The equation of electromotive forces (2) becomes under this hypothesis,

$$0 = R\, i + \frac{L\, di}{dt}. \qquad (10)$$

The solution of this equation is readily found since the variables admit of separation. Thus

$$\frac{di}{i} = -\frac{R}{L}\, dt$$

$$\therefore \quad log\, \frac{i}{c} = -\frac{Rt}{L},$$

$$\text{or} \quad i = c\, \varepsilon^{-\frac{Rt}{L}}. \qquad (11)$$

The constant of integration c is determined by the particular supposition introduced that when we begin to count the time, the current, has its steady value I. This gives $c = I$. Hence we have—

$$i = I\, \varepsilon^{-\frac{Rt}{L}}. \qquad (12)$$

Referring to the general solution (9), we might have writ-

*For the first section of this article see THE ELECTRICAL WORLD, May 14, 1892, p. 334.

ten (12) at once. For as $f(t) = 0$ [see (6)], the integral vanishes, and we have (11) as an immediate result.

This equation (12) is graphically represented in Fig. 1 where the ordinates represent the values of the current at any time after the E. M. F. is removed. The self-induction of the circuit prevents the current from falling immediately to zero. This is evident from equation 12. If we make $L = 0$, i becomes zero. The current which flows after the removal of the E. M. F. is called the extra current of self-induction. The energy required to cause such a current to flow is that energy which was previously stored up in the field and is now returned to the circuit. When t has the value $\frac{L}{R}$ the exponent of ε becomes minus unity, and we have the relation $\frac{I}{i} = \varepsilon = 2.71828$. $\frac{L}{R}$ represents therefore the time that it takes for the current to fall to one εth part, that is to $\frac{1}{2.71828}$ of its original value. This is sometimes called the time constant of the circuit, and denoted by T, that is $\frac{L}{R} = T$. The curve represents a logarithmic function of the time and approaches the axis as an asymptote. This means that the current becomes smaller and smaller, but never becomes zero until an infinite time has elapsed.

The following method shown in Figs. 2 and 3 will be

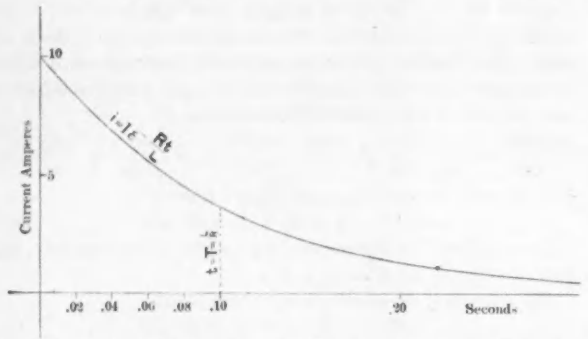


FIG. 1.—CURVE SHOWING THE DYING AWAY OF CURRENT AT ANY TIME AFTER THE REMOVAL OF THE IMPRESSED E. M. F. FROM A CIRCUIT WHOSE RESISTANCE R IS .1 OHM AND COEFFICIENT OF SELF-INDUCTION L IS .01 HENRY.

found to be a convenient way of graphically constructing a curve, whose equation is of the form

$$y = c\,\varepsilon^{-\alpha x}$$

where c and α have any real values whatever.

Lay off $OA = c$. Then OA = the value of y when $x = 0$ and may be called y_0, *i. e.*, $y_0 = c = OA$.

Lay off $OB = c\,\varepsilon^{-\alpha x_1}$. Then OB = the value of y when $x = x_1$, and may be called y_1, *i. e.*, $y_1 = c\,\varepsilon^{-\alpha x_1} = OB$.

Hence $\frac{y_0}{y_1} = \frac{OA}{OB} = \varepsilon^{\alpha x_1}$.

If arcs AA' and BB' are described from the centre O, and a line BC drawn parallel with $A'B'$, thence another line CD drawn parallel with AB, and so on, alternately drawing lines parallel with $A'B'$, and with AB as in the figure, then the distances OA, OB, OC, OD, etc., will represent the values of y respectively as x takes the values $0, x_1, 2x_1, 3x_1$, etc. For if y, y_1, y_2, y_3, etc., denote the values of y, when x takes the values $0, x_1, 2x_1, 3x_1$, respectively, we have

$$y_0 = c$$

$$y_1 = c\,\varepsilon^{-\alpha x_1} \quad \therefore \frac{y_0}{y_1} = \varepsilon^{\alpha x_1}$$

$$y_2 = c\,\varepsilon^{-2\alpha x_1} \quad \therefore \frac{y_1}{y_2} = \varepsilon^{\alpha x_1}$$

$$y_3 = c\,\varepsilon^{-3\alpha x_1} \quad \therefore \frac{y_2}{y_3} = \varepsilon^{\alpha x_1}$$

Hence $\frac{y_0}{y_1} = \frac{y_1}{y_2} = \frac{y_2}{y_3} = \frac{y_3}{y_4} = \text{etc.} = \varepsilon^{\alpha x_1}$

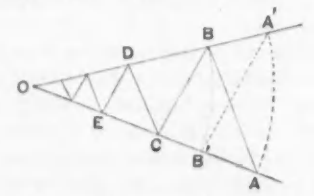


FIG. 2.—GRAPHICAL METHOD OF CONSTRUCTING CURVE.

But by the construction of the figure, and by remembering that $OA = y_0$ and $OB = y_1$,

$$\frac{OA}{OB} = \frac{OB}{OC} = \frac{OC}{OD} = \frac{OD}{OE} = \text{etc.} = \varepsilon^{\alpha x_1}$$

Hence $y_0 = OA$, $y_1 = OB$, $y_2 = OC$, $y_3 = OD$, etc.

To construct the curve, Fig. 3, whose equation is $y = c\,\varepsilon^{-\alpha x}$, proceed as follows: Upon two intersecting lines, as in Fig. 2, lay off the distances $y_0 = c$, and $y_1 = c\,\varepsilon^{-\alpha x_1}$, which latter must be calculated, and obtain the values of OC, OD, etc., as described. Then will y_0, y_1, y_2, etc., or OA, OB, OC, etc., be the successive ordinates of the logarithmic curve, Fig. 3, at distances $0, x_1, 2x_1, 3x_1$, etc., and the curve may be drawn.

Case II. Establishment of a Current on Introduction of a Constant Electromotive Force into a Circuit Containing Resistance and Self-Induction.—Suppose a source of constant E. M. F. is suddenly introduced into a circuit of resistance R and self-induction L. The differential equation in this case is

$$E = Ri + L\frac{di}{dt}, \qquad (13)$$

where E is a constant. The variables may be separated here as in the previous case, thus:

$$\frac{di}{i - \frac{E}{R}} = -\frac{R}{L}\,dt$$

$$\text{and } \log\frac{1}{c}\left(i - \frac{E}{R}\right) = -\frac{Rt}{L}$$

$$\text{therefore } i = \frac{E}{R} + c\,\varepsilon^{-\frac{Rt}{L}} \qquad (14)$$

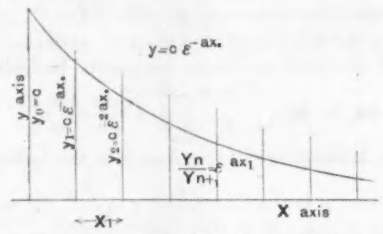


FIG. 3.—LOGARITHMIC CURVE OF EQUATION (12).

The constant of integration c is determined by the condition that, when $t = 0$, $i = 0$, $\therefore c = -\frac{E}{R}$. We have then as a result,

$$i = \frac{E}{R}\left(1 - \varepsilon^{-\frac{Rt}{L}}\right) = I\left(1 - \varepsilon^{-\frac{Rt}{L}}\right) \qquad (15)$$

Referring to the general solution (9) we might have substituted $f(t) = E$ a constant [see (6)], and written at once equation (15). For in this case we easily find the required integral:

$$\int E\,\varepsilon^{\frac{Rt}{L}}\,dt = E\frac{L}{R}\,\varepsilon^{\frac{Rt}{L}} \qquad (16)$$

Multiplying this by the coefficient $\frac{1}{L}\,\varepsilon^{-\frac{Rt}{L}}$ (9) becomes

$$i = \frac{E}{R} + c\,\varepsilon^{-\frac{Rt}{L}} \qquad (17)$$

Replacing c by $-\frac{E}{R}$ we have,

$$i = \frac{E}{R}\left(1 - \varepsilon^{-\frac{Rt}{L}}\right) \qquad (18)$$

a result identical with (15).

Here we notice that, if the self-induction is zero, the

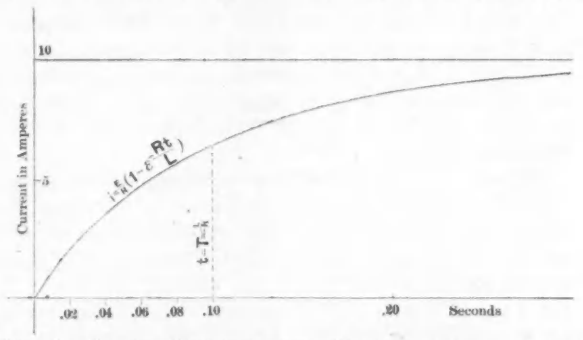


FIG. 4.—CURVE SHOWING THE ESTABLISHMENT OF CURRENT AT ANY TIME AFTER THE INTRODUCTION OF AN E. M. F. INTO A CIRCUIT WHOSE RESISTANCE R IS .1 OHM, AND COEFFICIENT OF SELF-INDUCTION L IS .01 HENRY.

equation becomes simply Ohm's law. That is, the self-induction of the circuit prevents the current from reaching its full value immediately after the introduction of the E. M. F.

The increase of the current with the time is shown by the curve Fig. 4. This is a logarithmic curve similar to that in Fig. 1, with the ordinates measured downward from the horizontal line O_1A, at a distance above the axis equal to the maximum value I of the current.

Case III. Harmonic Impressed E. M. F. in a Circuit Containing a Resistance and Self-Induction.—Let us now suppose that in a circuit containing resistance and self-induction there is a simple harmonic impressed E. M. F., that is that the E. M. F. is a sine function of the time, thus:

$$e = f(t) = E\sin\omega t \qquad (19)$$

Here E is the amplitude or maximum value of the impressed E. M. F., and ω is the angular velocity equivalent to $2\pi n$, or $\frac{2\pi}{T}$, where n denotes the number of complete periods per second and T the time of one complete period.

The general solution for the current, equation (9), is:

$$i = \frac{\varepsilon^{-\frac{Rt}{L}}}{L}\int \varepsilon^{\frac{Rt}{L}} f(t)\,dt + c\,\varepsilon^{-\frac{Rt}{L}} \qquad (20)$$

Substituting in (20) the value for $f(t)$ in (19) the general expression becomes, according to the particular hypothesis of a sine E. M. F.,

$$i = \frac{E\,\varepsilon^{-\frac{Rt}{L}}}{L}\int \varepsilon^{\frac{Rt}{L}}\sin\omega t\,dt + c\,\varepsilon^{-\frac{Rt}{L}} \qquad (21)$$

This is integrated by the formula

$$\int e^{\alpha x}\sin\beta x\,dx = \frac{e^{\alpha x}}{\alpha^2 + \beta^2}(\alpha\sin\beta x - \beta\cos\beta x) \qquad (22)$$

Replacing α by $\frac{R}{L}$, β by ω, and x by t, in equation (22), we have the integration indicated in (21), and equation (21) then becomes

$$i = \frac{E}{L\left(\frac{R^2}{L^2} + \omega^2\right)}\left(\frac{R}{L}\sin\omega t - \omega\cos\omega t\right) + c\,\varepsilon^{-\frac{R}{L}t} \qquad (23)$$

This may be written in simpler form by the use of the trigonometric formula

$$A\sin\theta + B\cos\theta = \sqrt{A^2 + B^2}\sin\left(\theta + \tan^{-1}\frac{A}{B}\right) \qquad (24)$$

Reduced by this formula to its simplest form, we have from (23) the value of the current at any instant of time.

$$i = \frac{E}{\sqrt{R^2 + L^2\omega^2}}\sin\left(\omega t - \tan^{-1}\frac{L\omega}{R}\right) + c\,\varepsilon^{-\frac{Rt}{L}} \qquad (25)$$

After a very short time the exponential term in this equation, containing the arbitrary constant of integration, becomes inappreciably small, and may be neglected. Just what effect this term has during the short time will be considered later. The equation shows that, where there is an impressed sine electromotive force in a circuit, the current

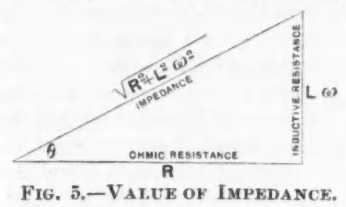


FIG. 5.—VALUE OF IMPEDANCE.

is likewise a sine function of the time, and that the current lags behind the electromotive force by an angle whose tangent is $\frac{L\omega}{R}$. If there is no self-induction and $L = 0$, equation (25) becomes

$$i = \frac{E}{R}\sin\omega t$$

which is a direct result of Ohm's law. Thus the self induction not only causes the current to lag behind the impressed E. M. F., but also diminishes the maximum value of the current.

When $\sin\left(\omega t - \tan^{-1}\frac{L\omega}{R}\right)$ becomes unity, the current has its maximum value I, and

$$I = \frac{E}{\sqrt{R^2 + L^2\omega^2}} \qquad (26)$$

The term "impedance" has been applied to the expression $\sqrt{R^2 + L^2\omega^2}$, the apparent resistance of a circuit containing ohmic resistance and self-induction, and an impressed sine electromotive force.

The equation (26) may be written

$$\text{Maximum current} = \frac{\text{Maximum E. M. F.}}{\text{Impedance.}} \qquad (27)$$

$$\text{Since effective current} = \frac{1}{\sqrt{2}}\text{ maximum current, and}$$

$$\text{effective E. M. F.} = \frac{1}{\sqrt{2}}\text{ maximum E. M. F.}$$

$$\text{Effective current} = \frac{\text{Effective E. M. F.}}{\text{Impedance.}} \qquad (28)$$

The value of impedance is graphically represented in Fig. 5. $L\omega$ is sometimes called the inductive resistance in contradistinction to the ohmic resistance R.

It has been shown above that the tangent of the angle of lag is $\frac{L\omega}{R}$ The angle of lag is therefore represented by θ in Fig. 5.

FIG. 6.—VALUE OF IMPRESSED E. M. F.

The triangle may be drawn so that the three sides represent E. M. F. as in Fig. 6.

Here $R\,i$ represents the E. M. F. necessary to overcome the ohmic resistance, and is in the same direction as the current.

$L\omega I$ is at right angles to this and represents the counter E. M. F. of self-induction.

$\sqrt{R^2 + L^2\omega^2}$ is the impressed electromotive force E.

θ is the angle by which the current lags behind the impressed E. M. F.

It is convenient to consider the impedance as a resistance, and the propriety of doing so is shown by its dimensions, which are the same as those of resistance, that is a velocity in the electromagnetic system of units.

The dimensions of resistance, R, are $\frac{length}{time} = velocity$.

The dimension of the coefficient of self-induction L is *length*. The dimension of an angular velocity ω is $\frac{1}{time}$.

Therefore the dimensions of $L\,\omega$ are $\frac{length}{time} = velocity$, and thus the impedance has the same dimensions as a resistance.

Case IV. Periodic E. M. F. Which Is Not Harmonic, in Circuits Containing Resistance and Self-Induction.— In Case III. the solution was given for a circuit containing an impressed E. M. F. which was a simple sine function of the time. Now let us suppose that the E. M. F. does not follow a simple sine law, but that it is the sum of two components each following a sine law, that is,

$$e = E_1 \sin \omega t + E_2 \sin (b\,\omega\,t + \theta) \qquad (29)$$

Substituting in the general expression for current (9) this value for $f(t)$, we have

$$i = \frac{E_1}{L}\,\varepsilon^{-\frac{Rt}{L}} \int \varepsilon^{\frac{Rt}{L}} \sin\,\omega\quad dt + \frac{E_2}{L}\,\varepsilon^{-\frac{Rt}{L}} \int \varepsilon^{\frac{Rt}{L}} \sin (b\,\omega\,t + \theta)\,dt + c\,\varepsilon^{-\frac{Rt}{L}}. \qquad (30)$$

Performing the indicated integrations by use of the formula

$$\int \varepsilon^{\alpha x} \sin (\beta x + \theta) = \frac{\varepsilon^{\alpha x}}{\alpha^2 + \beta^2} \left\{ \alpha \sin (\beta x + \theta) - \beta \cos (\beta x + \theta) \right\} \qquad (31)$$

we have

$$i = \frac{E_1}{L\left(\frac{R^2}{L^2} + \omega^2\right)} \left\{ \frac{R}{L} \sin\,\omega\,t - \omega\,\cos \omega\,t \right\} + \frac{E^2}{L\left(\frac{R^2}{L^2} + b^2\,\omega^2\right)} \left\{ \frac{R}{L} \sin\,(b\,\omega\,t + \theta) - b\,\omega \cos\,(b\,\omega\,t + \theta) \right\} + c\,\varepsilon^{-\frac{Rt}{L}} \qquad (32)$$

Simplifying by formula (24) this becomes

$$i = \frac{E_1}{\sqrt{R^2 + L^2\,\omega^2}} \sin \left(\omega\,t - \tan^{-1} \frac{L\,\omega}{R}\right) + \frac{E_2}{\sqrt{R^2 + L^2\,b^2\,\omega^2}} \sin\,(b\,\omega\,t + \theta - \tan^{-1} \frac{L\,b\,\omega}{R}) + c\,\varepsilon^{-\frac{Rt}{L}} \qquad (33)$$

By this equation it is seen that each simple sine impressed E. M. F. gives rise to a simple sine term in the resulting current equation. The result may therefore easily be extended, and we may say that, if there are n simple sine impressed E. M. F's. of the form $E \sin (b\,\omega\,t + \theta)$, where E, b, and θ have different values in each component term, the current equation will be the sum of n terms of the form,

$$\frac{E}{\sqrt{R^2 + L^2\,b^2\,\omega^2}} \sin \left\{ b\,\omega\,t + \theta - \tan^{-1} \frac{L\,b\,\omega}{R} \right\}$$

plus the term $c\,\varepsilon^{-\frac{Rt}{L}}$ containing the arbitrary constant.

Here E, b and θ have the same values in each term as they do in the corresponding terms of the impressed E. M. F.

Expressing the current as a summation we have

$$i = \sum_{E,\,b,\,\theta} \frac{E}{\sqrt{R^2 + L^2\,b^2\,\omega^2}} \sin \left\{ b\,\omega\,t + \theta - \tan^{-1} \frac{L\,b\,\omega}{R} \right\} + c\,\varepsilon^{-\frac{Rt}{L}} \qquad (34)$$

when the impressed E. M. F is

$$e = \sum_{E,\,b,\,\theta} E \sin \left\{ b\,\omega\,t + \theta \right\} \qquad (35)$$

In these sums E, b and θ may have n values, but they must be the same values in each sum, giving rise to the same number of terms in each.

It was first shown by Fourier that such a sum of simple sine terms as that represented in equation (34) may express any single valued function whatever, and thus we see that the equation expresses the most general case of a current flowing in a circuit with resistance and self-induction, and may represent the current caused by any E. M. F. whatsoever.

The consideration of this most general expression for the current will be deferred until the case where the circuit not only contains resistance and self-induction, but also a condenser, has been taken up.

The "Pollock" Tramway System.

To the Editors of the Electrical World:

In the issue of March 19, page 195, of your esteemed journal, you gave a short description, accompanied by an illustration, of my tramway system, stating that my name was "Pollock." As the name, description and illustration are not exact, I take the liberty to write you.

In November, 1886, I invented and patented, with Mr. Binswanger, of London, a sectional system of underground conductor, the sections of which are shorter than the car, to obtain security, as the car always covers the section traveled by the current. The magnet fixed underneath the car makes the contact with an insulated continuous conductor. The movable parts of the contacts are inclosed hermetically in boxes to protect them from moisture, dust, etc., and by using several contacts at the same time for establishing connections, there is no sparking in the boxes. The very long delays in the patent office do not allow me to give you the details of construction. I wish to point out here only this, that I do not know of anybody who before me, that is before November, 1886, employed or proposed for electrical traction a system composed of insulated continuous sectional conductor, the sections of which are shorter than the car, and the latter having a magnet fixed underneath for making the contacts between the continuou and the sectional conductor by means of the attraction of this magnet, the contacts lasting only as long as they are under the influence of this magnet.

My system was described and illustrated as early as April 16, 1887, in *La Lumière Electrique*, and April 29 of the same year in the London *Electrical Review*.

In order to avoid errors in the future I hope you will kindly publish this. Yours truly. C. POLLAK,

APRIL 8, 1892. Frankfort-on-Main, Germany.

[Neither the article in question nor the illustration are of the Pollak system, nor was the description written by us. We do not think, therefore, that Mr. Pollak is justified in making this criticism.—ED.]

Multiphase Transmission and Distribution of Electric Energy.—I.*

BY A. RECKENZAUN.

Frankfort-Lauffen.—In a letter dated April 19, 1892, the Allgemeine Elektricitäts Gesellschaft, of Berlin, sends the results obtained by the testing committee of the Frankfort Exhibition with the Frankfort-Lauffen transmission plant. The official report, which has not yet been published, shows that a maximum efficiency of 75 per cent. was obtained between the turbine shaft at Lauffen and the terminals at Frankfort, and the various measurements have shown the following losses, viz.:—In the generating dynamo eight per cent., in the transmission leads 10 per cent., and in each transformer three per cent.

Heilbronn-Lauffen.—Long before the above exhibition plant was completed, and while numerous skeptics were discussing the probable failure of this gigantic experiment, Mr. Oscar von Miller had the courage to plan an installation for the city of Heilbronn, which was to obtain its energy from Lauffen by means of the three-phase system, and serve the double purpose of supplying light and power. The Portland cement works of Lauffen obtained the concession to electrically light Heilbronn, which is 12 kilometres distant. There is an available power of 1,500 h. p., of which 600 h. p. is used for the cement work, and 900 h. p. for the production and distribution of electric energy. The multiphase system was adopted because of its adaptability to long distance transmission, and especially on account of the ease with which small motors can be worked, and current for motive power is in great demand at Heilbronn.

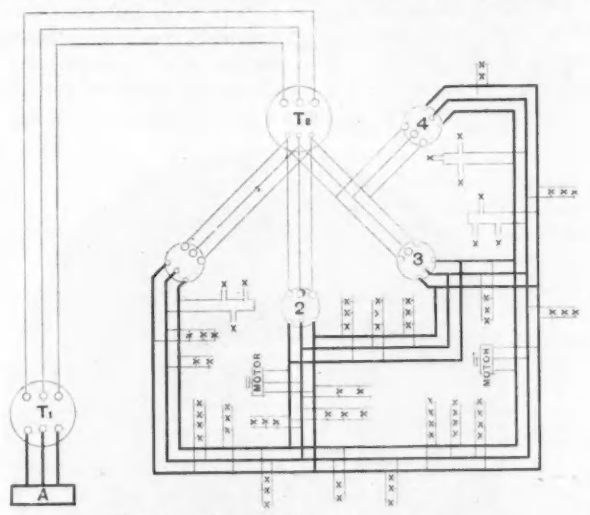


FIG. 1.—MULTIPHASE DISTRIBUTOR.

The current is generated at Lauffen by means of three dynamos, each capable of giving 4,000 ampères at a pressure of 50 volts. This is transformed up to 5,000 volts and about 38 ampères. Mr. von Miller prefers this "step-up" transformation to the use of alternators which would produce the high tension current direct, on the grounds that low tension dynamos are much safer and easier to maintain, and also on account of their higher efficiency, so that the loss, which in the transformer need not exceed 3 or 4 per cent., is fully compensated by these advantages.

The 5,000-volt current is transmitted through three bare copper wires, 6 millimetres thick, which are carried upon poles to the outskirts of the city of Heilbronn. Oil insulators are used, and these are fixed to cross bars upon wooden poles, varying in height from 8 to 14 metres. Some distance above the transmission wires there is a "barbed" steel wire running throughout the whole distance, and this serves as an excellent lightning conductor by being earthed at numerous places.

Fig. 1 represents in diagrammatic form the arrangement of the circuits, machine and lamps. Generator A and transformer T_1 are both at Lauffen. Transformer T_2 is at the outskirts of Heilbronn, and converts the 5,000 volts of the overhead line into 1,500 volts, to be carried into the city through underground mains. Mr. von Miller would not trust any system of underground mains to stand 5,000 volts with absolute safety, and as the energy had still to be carried to considerable distances, and economy in the sizes of conductors was important, he arranged for a second transformation. The current is thus conveyed by concentric cables to the transformers, 1, 2, 3 and 4, and thence distributed to the houses at a tension of 100 volts. Any desired number of these secondary transformers can be set up as convenient points; at present they are about 200 metres distant from each other. Notwithstanding the several transformations, there is an estimated loss of only 20 per cent., so that out of 200 kilowatts produced at Lauffen by each dynamo, 160 kilowatts are delivered at Heilbronn, and used in arc lamps, incandescent lamps and motors. The entire installation, including water power, has cost £18,750 up to the present, with 4,200 installed 16 c. p. lamps, or something less than £4 10s. per lamp. The electrical plant was the joint production of the Oerlikon Works and the Allgemeine Electricitäts Gesellschaft.

*From the *Electrical Review*, London.

A Test of the Patton Motor.

The Patton engine motor, as it is called, which has just been finished at the works of the Pullman Car Company at Pullman, Ill., was given a test on May 10 at that place. A number of street railway men were present. The tests as reported have been entirely successful. Some very severe trials of the motor's speed and power were made. The Patton motor, as our readers are perhaps aware, is constructed along very different lines than those now in use on electric street railways. The car contains an entire and independent plant and has no connection whatever with a central station. A gas motor placed upon the car is supplied with gas from tanks carried upon the car roof. This gas engine drives a dynamo generating current which is used either to drive the motor or to charge a set of accumulators, or both at the same time. The accumulators are kept charged as near to their full capacity as possible, and whenever necessary the motor may be supplied with current from the dynamo and accumulator cells at the same time, and provision is also made for driving the motor by the storage batteries alone. The engine is connected to the dynamo by a friction pulley and this operates continuously whether the car is running or not. Whatever current is generated in excess of that required by the motor is utilized in charging the storage cells. It is said that in the tests at Pullman the car was able to run itself easily up a 10 per cent. grade. The car is fitted with a 20 h. p. motor and the entire outfit weighs about 14,000 pounds.

The Manufacture of Lead-Covered Cables.

In the manufacture of cables considerable difficulty has been experienced in lowering the static capacity to the figure demanded in the specifications of the telephone and other companies. A short time ago a figure of .20 or .21 micro-farads was considered satisfactory, but this has been decreased year by year until now .080 micro-farad is required. These results have been obtained by the Edison General Electric Company since it has put in the large lead presses which enable it to turn out complete lead-covered cables. With these new facilities cables have been produced which show a static capacity of only .075 micro-farad combined with a remarkably high insulation.

The Edison company has avoided this difficulty by adopting the process of Siemens & Halske. Cold lead is used and every particle of oxide is removed before insertion in the press. The lead is forced over the cable by heavy pressure and produces an armor superior in many respects to that resulting from the old methods. It is claimed that when two pipes formed by the hot and cold processes are tested by hydraulic pressure the fluid will ooze through the former while the latter remains dry.

A cable recently supplied to the Metropolitan Telephone Company, of New York, has given excellent satisfaction, and an order has been received from the Pacific Telephone and Telegraph Company, of San Francisco, for a cable to contain not less than one hundred pairs of wires.

The Practical Study of Electricity.

The rapid growth of the two-year course in electrical engineering at the Johns Hopkins University has been very materially assisted by the introduction of several new features. One of these has been the series of tests made by the students of various street railways and electric lighting plants.

The last test to be made this year was that of the Neversink Mountain electric road at Reading, Pa. This road is operated by the Edison system, and is run by two 240 h. p. Hercules turbines coupled together and belted by double reduction to two Edison 100 k. w. dynamos. Two more dynamos the same size are now being put in to furnish power to the Black Bear road. The cars are 35 feet over all, and are fitted with two 25 h. p. single reduction Edison motors each.

The party, consisting of 22 students, spent nearly five days there, and under the direction of Instructors H. S. Hering and W. S. Aldrich some very interesting tests of the road were made as to the general efficiency of the plant, the efficiency of individual cars at various speeds and positions of switch, the determination of the traction coefficient, etc. Advantage was taken of an excursion to test the road under very heavy loads; some good data as to the efficiency of turbines were also obtained.

On the return to Baltimore the party spent two days in Philadelphia, visiting the J. G. Brill company, Fire Alarm Service, Telephone Exchange, Edison and Brush stations, Baldwin Locomotive Works, William Sellers company, and Cramps' ship yards.

Dynamo and Motor Calculation.

BY C. H. BEDELL.

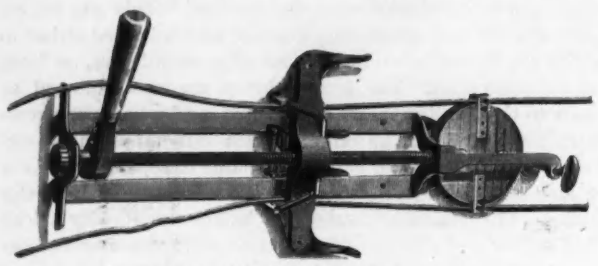
In reply to Mr. J. C. Lincoln's comment on my paper published in THE ELECTRICAL WORLD of April 30, it will only be necessary to refer to Kapp's "Electric Transmission of Energy," page 281, and Thompson's "Dynamo-Electric Machinery," fourth edition (just published), page 335, where several methods are given for connecting the sections of an armature so that the electromotive forces generated under like poles are in series. It is to such machines that my statement refers.

Mr. Lincoln would be correct in his statement if there were no other method of winding than the continuous one of the usual Gramme ring. If the connections given in the references mentioned above are carefully studied, it will be seen that the "case of multipolar machines having the electromotive force generated under like poles in series" *is* possible.

A New Wire Stretcher.

A very useful piece of apparatus, the invention of Mr. Herbert S. Shaw, of Webster, Mass., is shown in the accompanying illustration. The device is one for the stretching of electric wires in interior work, and is to enable one man to put up wires without assistance, which is practically impossible in the ordinary method used.

This invention consists of a frame provided with a track or guide upon which a block, carrying the gripping devices,



SHAW WIRE STRETCHER.

runs. This block is moved by means of a threaded rod and nut, which is worked by a pawl and racket. The two lateral extensions are levers, whose eccentric surfaces form, with shoulders on the block, the grip for the wires. A second set of levers underneath forms a grip for the third wire in a three-wire system, or for a single wire, and is made for cables of considerable size.

The operation of the instrument is quite simple. Two spurs or brads in the end are placed against the cleat, rosette, insulator or molding and the thumb screw in the extension is operated to force the other end firmly against the wall. The wires are then placed in the jaws, which are closed by springs, as shown. It is then only necessary to work the handle in order to stretch the wires to any desired tension. A milled head on the end of the rod enables it to be turned backward.

This device will be manufactured by the inventor himself.

A New Current Tap for Adapting the Incandescent Current to Use in Medical Work.

The increased use of electricity in medical treatment has been the occasion for the invention of numberless devices tending to a greater facility in its application. The methods heretofore in use have all been those made possible by the use of the ordinary galvanic battery. But the latter's liability to get out of order has made it anything but a perfect medium of application. The most unique method for the administration of the galvanic current is using it directly from the incandescent light wires. When means for its

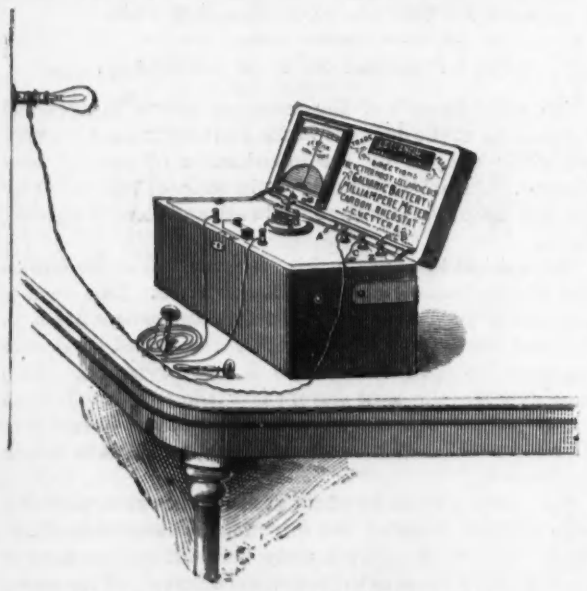


FIG. 2.—CURRENT TAP FOR MEDICAL USE.

proper reduction to within limits insuring the safety of the patient are employed, it is, by reason of its economy and absence of trouble, much more to be preferred than the old style battery system. Yet the means heretofore used have not been such as to positively eliminate every danger.

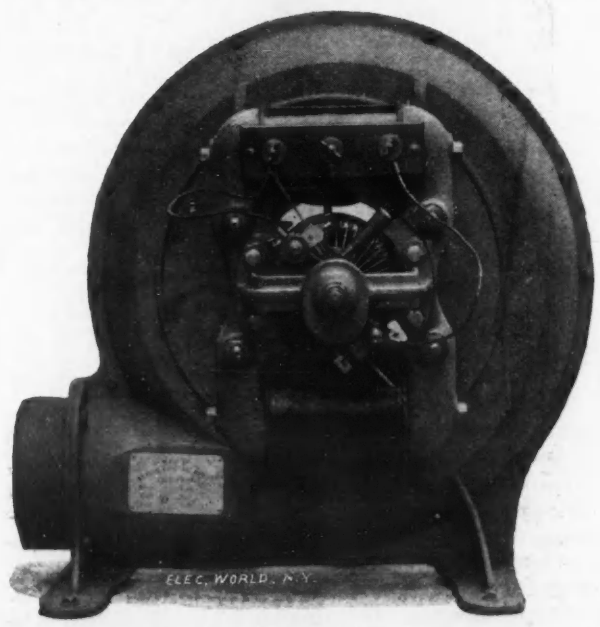
In Fig. 1 is shown an arrangement which when used in connection with a proper controller will tend to simplify matters and render this means of obtaining current safe even in the hands of a novice. An incandescent lamp socket is so modified with tapping sockets and a switch as to make it possible to obtain either a current with the lamp in series or one in which all resistance is thrown out and which can be used up to the amount allowable by the safety fuse plugs. The last condition would only be of use where a force sufficient for motor or drill work was desired. Sockets 1 and 3 are then tapped and an external resistance used to modify the current to the right proportion. For

FIG. 1.—CURRENT TAP FOR MEDICAL USE.

actual therapeutic use the sockets marked 1 and 2 are used, and the current guarded by the resistance of the lamp which is then in circuit will never be able to gain in strength above one-half ampère at 110 volts, a proportion well fitted for medical treatment. Fig. 2 shows the instrument used in connection with the Vetter current controller and milliampère meter. The controller mentioned was described in a former issue, but furnishes a means of modification which when used in series with the instrument described above will make an outfit for the physician which is very desirable.

A Blower for Use in the Navy.

Electrical manufacturers are thoroughly familiar with the severe requirements for all classes of work intended for use in United States marine plants. The apparatus that succeeds in fulfilling the requirements specified for the naval plants must first undergo a very severe and long con-



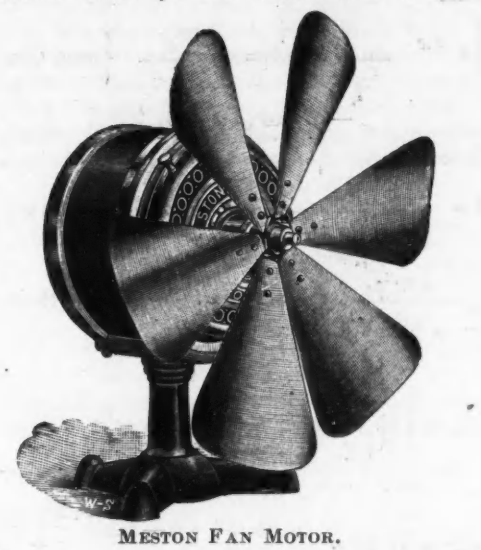
ARNOLD BLOWER FOR USE IN THE UNITED STATES NAVY.

tinued test for endurance, efficiency and durability. This is true of motor installations as well as electric light plants intended for the naval vessels, and we take pleasure in illustrating on this page a motor and fan which is one of four similar sets built for the United States Navy by the Arnold Electric Manufacturing Company, of Chester, Pa. These will be used for ventilating the dynamo rooms on board the cruisers Texas, Maine, Cincinnati and Raleigh. The Texas and Maine plants will have 35-inch fans, each operated by a 2-h. p. motor; while the Cincinnati and Raleigh. will be equipped with 30-inch fans. each of which will be driven by a 1-h. p. motor connected to an 80-volt circuit. The current used is 11 ampères, and at the speed of 1,340 revolutions per minute the fan will deliver in that time 1,300 cubic feet of air at a pressure of 1½ ounces. The total weight of the plant is 375 pounds, and manufacturers claim for it an efficiency of 92 per cent. The 35-inch blower operated by a 2-h. p. motor runs at a speed of 1,375 revolutions per minute and delivers 2,200 cubic feet of air in the same time at a pressure of 2½ ounces. This machine is said to show a commercial efficiency of 94 per cent., as indicated by the test made before placing it on board the vessel. Its total weight is 550 pounds.

As will be seen from the illustration the motor is mounted directly upon the shaft of the blower. The view shown is that obtained when one is looking directly at the end of the armature shaft. The frame of the motor is mounted upon the side of the blower frame and in case it is necessary to run the blower in an inverted position the motor can be arranged for this position by simply shifting the bearings of the armature shaft the other side up.

The Meston Fan Motor.

The accompanying illustration shows a fan motor intended for alternating current circuits. It is manufactured by the Emerson Electric Manufacturing Company, of St. Louis, Mo. The fan is 12 inches in diameter and has six blades. The speed is variable up to 2,000 revolutions per minute when the fan is mounted on the armature shaft. The current required is 1.8 ampères when operated on a 52-volt circuit. The motor is finely finished in polished bronze and black enamel. The base of the stand is made of a tripod furnished with soft rubber cushions, to give a secure footing and to prevent all noise caused by vibration. Large polished bronze castings which serve as bearings for the armature shaft are of an ornamental design and are strong and substantial. The motor is completely enclosed, no wire being visible. None of the working parts are exposed to possible injury, at the same time they are easily accessible, as the end covers may be removed entirely and the armature taken out without disconnecting any wires or disarranging any adjustment. The speed and power of the motor can be regulated and the direction of rotation may be reversed if necessary. The commutator is made of



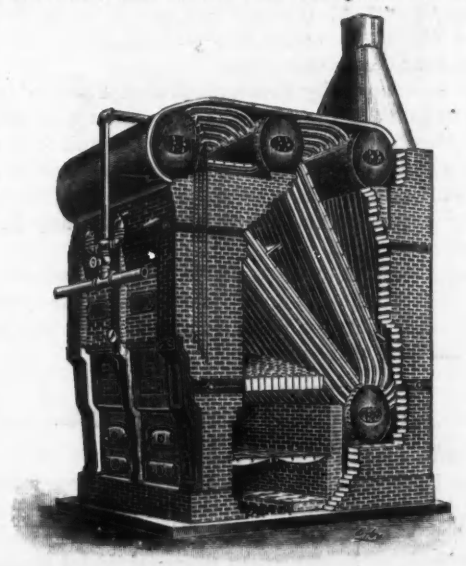
MESTON FAN MOTOR.

tempered copper and the brushes are intended to last at least one entire season. These are made of carbon of special composition and 2⅛ inches in length.

The Stirling High Pressure Water-Tube Boiler.

The accompanying cut is an illustration of the Stirling water-tube boiler. The construction of this boiler is a departure from the general construction of other water-tube boilers and possesses many excellent features. The boiler consists, as shown, of three upper drums, and a lower or mud drum, made of the best flange steel tested for elongation, tensile strength and ultimate strength. The steel used in these drums has a tensile strength of between 55,000 and 60,000 lbs. The tubes are made of the best mild steel and the bends are made cold by special hydraulic machinery, and is done without either kinking or straining the material. The manholes on the heads are made from material three-quarters of an inch thick, and are formed by hydraulic machinery, and afterward faced to a perfect fit on a special elliptical chuck. The manhole covers are made of material which is one inch thick. The studs are both threaded and riveted, and made of the best Norway iron. The arches for holding the manholes in place are made from forged steel.

The boiler cannot change its shape and has neither head braces nor stay bolts to break or loosen. The drilling of so many holes in the drums weakens them, and in order to wholly overcome this feature the tube plates are made of



STIRLING WATER TUBE BOILER.

material which is $\frac{9}{16}$ of an inch thick, and after drilling the holes out of this there is the strength of a ⅝-inch plate throughout all the drums of the boiler. The Hartford Steam Boiler Inspection and Insurance Company, as well as the United States inspection laws, allow a ¼-inch plate for 36-inch shells, and therefore these drums are 50 per cent. above their requirements. The tubes are less than ¼ of an inch thick and 3¼ inches in internal diameter, and are expanded into accurately bored holes in the drums.

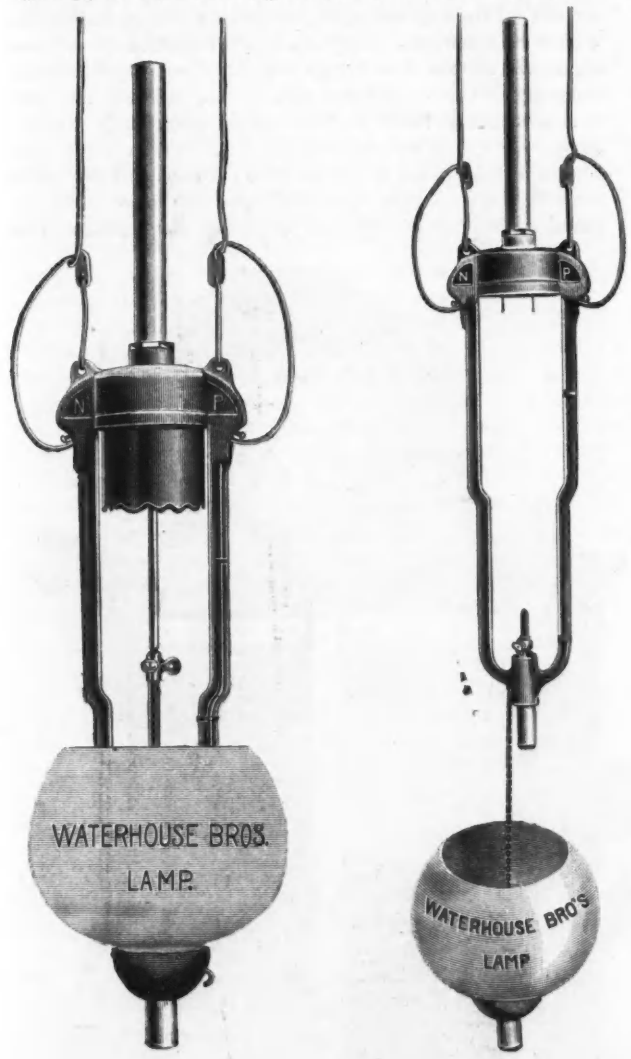
The boiler has perfect freedom to expand and contract in all directions, and is claimed to be very economical in the use of fuel for the reason that the heating surfaces are thin and always clean, and are so placed as to be passed and enveloped by the hot gases from the moment they leave the surface of the fire until they enter the stack. The heating surfaces are thin because they are almost entirely made of tubes which are less than ¼ of an inch thick, and these tubes are always practically clean on the outside because they are set at such an angle that it is impossible for any amount of soot to collect on them. The water is fed into the back upper drum, and during its passage to the mud drum (which requires about twenty minutes when the boiler is working at its rated capacity) it comes in contact with the heated gas currents, and becomes heated to a temperature of over 300 degrees. At this temperature all the carbonate of lime, sulphate of lime, magnesia and other impurities are separated from the feed water and deposited in the mud drum, where they are easily blown off, thus avoiding scale in the tubes exposed to the maximum heat. As a result of this operation the two front banks of tubes are always filled with chemically pure water.

The entire absence of handhole plates, which cause much annoyance from leakage, is another excellent feature. The steam furnished by these boilers is remarkably dry, and in carefully conducted tests made by such authorities as Prof. M. E. Cooley, of Ann Arbor, Mich., it has been shown that the steam carried less than half of one per cent. of moisture, and this, too, when the boilers were running 75 per cent. above their rated capacity, and the temperature of the gases at the chimney was only 350 degrees.

It is claimed that over 100,000 h. p. of these boilers have been sold during the past three years, and that they have given unqualified satisfaction. The general offices of the company are in Chicago, but the New England agent is J. Bradford Sargent, 620 Atlantic avenue, Boston.

Waterhouse Arc Lamp for Arc or Incandescent Circuits.

An arc lamp that can be made with slight changes to burn on either an arc or incandescent circuit, and from 400 to 2,000 c. p., has long been looked for by users of electric light apparatus, as it frequently occurs that where incandescent apparatus only is in use, some arc lamps are required, and yet not often enough to warrant the purchase of apparatus for that special purpose. Again, central stations often find all their arc dynamos or circuit capacity fully occupied while there is ample to spare on their incandescent machines and lines. Or they may have 2,000 c. p. lamps and want to use only 1,200 c. p., or *vice versa*. To meet these requirements Waterhouse Bros., of Hartford, Conn., are now manufacturing what might be called a universal arc lamp. This lamp is new in style and original in construction, and a description of it will, no doubt, prove interesting to both central station and isolated plant owners and operators.



FIGS. 1, 2 AND 3.—THE WATERHOUSE ARC LAMP.

These lamps are manufactured and can be sold in two separate parts, the frame and mechanism as shown in Figs. 2 and 3. The same frame and carbon rod are used for any current, while the mechanism as shown in Fig. 4 for incandescent circuits differs slightly from that for arc circuits, but all fit the same frame. All parts are made entirely by machinery, without the aid of hand tools, thereby insuring exact duplicates and interchangeability. By uniting all the working parts of these lamps in a frame constructed of a single casting, as shown by Fig. 4, an exact adjustment of the parts is secured and the parts are rigidly held in place. This enables the manufacturers to produce lamps so that the action of one will be exactly like that of every other, and gives the operator a lamp that can be quickly and inexpensively repaired or changed from one

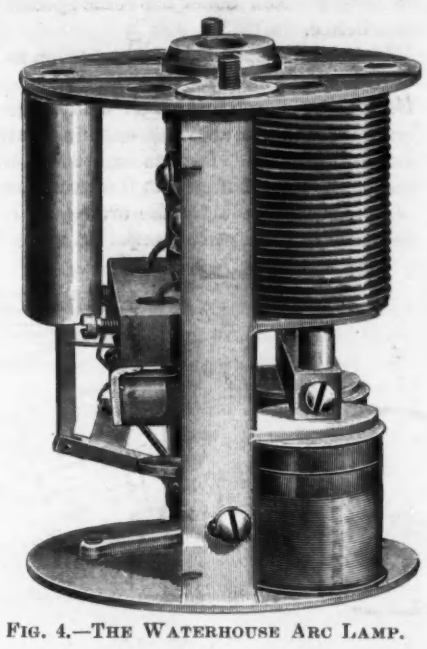
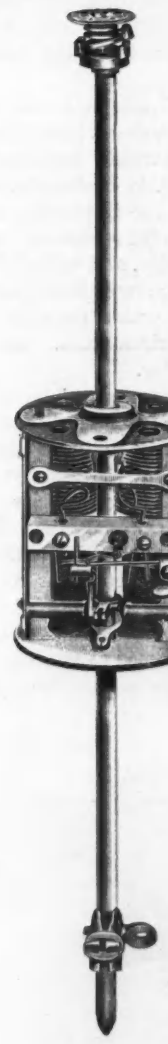


FIG. 4.—THE WATERHOUSE ARC LAMP.

circuit or candle power to another without removing the frame from its hanging position and without the aid of skilled labor.

There is but one insulating washer in or about the lamp, the top of the frame being filled with an insulating cement, in which the terminals and anchor plate to which the mechanism as shown in Fig. 3 is fastened by two bolts, while the lower carbon holder is also held in position by cement. The lamp is weather proof, and requires no hood when exposed to the elements.

The globe holder is of cup shape and dust tight for inside use, so no sparks can fall from the lamp, and it is properly drained for outside use. It is made to swing down from the lamp so it and the globe can be easily tipped and cleaned without unfastening the screws.



The advantages of the clutch form of lamp have been retained, and it is claimed that, by a peculiar device on the top of the carbon rod, the drop or overfeeding is avoided. This feature is particularly noticeable, it is said, when the lamps are burning on incandescent circuits; the feed being so accurate and positive that the see-saw effect, so often objected to, is entirely overcome, giving a steady and even light from both lamps in series.

The Kelvin.

With the approval of the London Board of Trade and the consent of Sir William Thomson the "unit" of one thousand watt-hours is hereafter to be called a kelvin. This term has already been adopted by the London *Electrician*. There is some question as to whether any name was needed and whether the simple term "unit" was not sufficient for all purposes. While Lord Kelvin certainly deserves the honor and the unit should bear his name perhaps in preference to any other, yet there is some ground for the objection to designating electrical units by proper names. The term contains no clue at all to its meaning, and the most learned scientist could not even make a guess at it without some clue. The science is not especially simple now, and it hardly seems advisable to further complicate it by the introduction of terms which convey no intelligent meaning to the average mind.

Telegraphic Reports on the Electrical Condition of the Atmosphere.

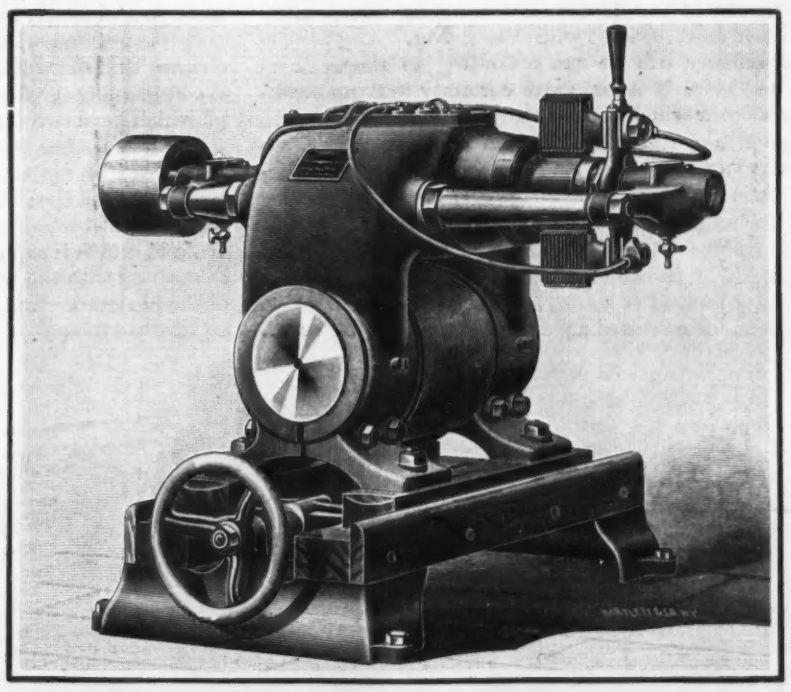
It has been suggested that the meteorological reports should contain statements from electricians in every large centre of telegraphic communication as to the electrical phenomena as forces of the atmosphere. At these different stations at certain definite times of the day or night the wires could be opened and in a very few moments information could be obtained by the use of the testing instruments as to the quantity of electricity and also moisture present in the atmosphere. That atmospheric electricity has a marked effect on telegraph wires is well known, and at the time of the recent aurora it was even possible to send messages without the use of batteries. The suggestion is one that might prove of some practical value.

With Edison at Schenectady.

We have just received what, so far as we are aware, is the first really artistic volume of photographs illustrating a large manufacturing plant that has ever been produced. It bears the title "With Edison at Schenectady, 1892." This handsome volume is the idea of Mr. Wm. H. Butler, an employé of the Edison company at Schenectady, and a Yale graduate. The collection consists of 24 plates about 9 × 11 inches in size upon which are mounted about 125 photographs showing the most important features of this interesting plant. The frontispiece plate contains portraits, accompanied by autographs, of Edison, Insull, Kruesi, Gilmore, Turner and other officials of the works. Full page photographs are given of the interiors of the larger shops, and groups of workmen in the various departments busily engaged in producing the Edison machines. Photographs are given of the different types of Edison street car motors, dynamos and stationary motors; the whole collection forming an intensely interesting study of the products of this immense electrical factory. It is indeed as instructive as it is entertaining, and many students will find it to contain more detailed information regarding the practical manufacture of heavy electrical machinery than a dozen text-books upon the various branches of electrotechnics. The book is handsomely and substantially bound in two styles, and is, we understand, to be sold by subscription only.

The New Jenney Motor.

The accompanying illustration shows the new type of Jenney motor which has just been brought out by the Jenney Electric Motor Company, of Indianapolis, Ind. In general appearance it does not differ much from the motors formerly built by this company, but some of its details have been changed to make it agree with the latest engineering practice. The field coils are now wound upon insulated spools, which are afterward slipped over the cores in the usual way. The bearings are self oiling, and in the larger sizes of motors are self-aligning. The brush holders are fitted with composite carbon brushes, and these are so attached to the rocker arm that the carbons always press upon the commutator at points which correspond to the opposite ends of the dynamo. Machines of more than one horse-power are fitted with a sliding base and a belt tightener. Motors of this type are made either shunt or series wound and are built in all the standard sizes, and for the voltages usually found on lighting and power circuits. To accompany these motors the Jenney company also manufactures a complete line of power generators.



THE JENNEY ELECTRIC MOTOR.

A Compact Central Station.

The accompanying illustration represents a unique electric lighting station installed on the Perry & Demeritt system. The plant (Fig. 2) has some interesting features, but is chiefly remarkable for the small space it occupies. A line of shafting 14 feet in length has a clutch coupling at each end, by which it is connected to two engines. The shaft is supported by three bearings four feet apart, and between the centre bearing and each outer one are three

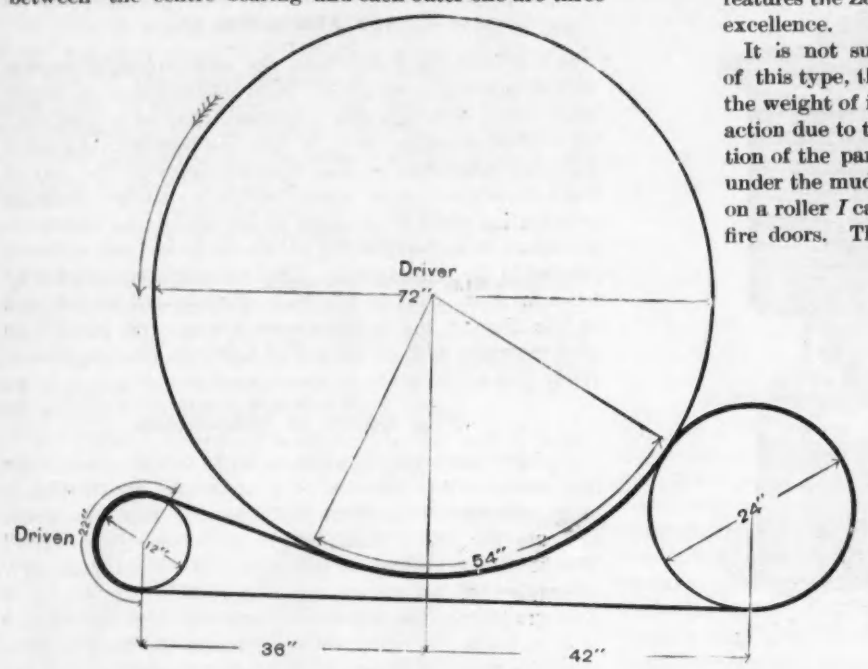


FIG. 1.—PERRY AND DEMERITT METHOD OF DYNAMO DRIVING.

pulleys. From these six Thomson-Houston arc light dynamos are run, placed so that no two machines are nearer than two feet and yet the whole occupy a floor space of only 15 feet by 17 feet. This is accomplished by the "L, P. & D." system of power transmission, better shown in Fig. 1. The belt encircles the dynamo or driven pulley and an idler or transmitter pulley and is supported by them in contact with the driver. By moving either the idler or the dynamo the belt can be brought in contact with or released from the driver and consequently the dynamo set in motion or brought to rest. As the belt contact on the driver is much greater than on the driven the power transmitted will be limited by the latter, but this, as it will be seen, is considerably greater than in the ordinary form of belted connections. This increased area of contact materially lessens the friction on the dynamo bearings.

The system has a great deal of flexibility and the dynamos are entirely independent. If one engine breaks down the other can drive all or nearly all the machines. If anything happens to one dynamo it is a simple matter to release its belt from contact with the driver. Any portion of the machinery can be run according to the work required, and there is a practical certainty that no breakdown will occur which can seriously affect the consumer.

The position of the driving, driven and transmitter pulleys can be varied to meet the requirements of any particular station, so long as the relative position of the three remain the same. The dynamo may be above, below or on the same level with the driver, or may be driven by the same pulley that furnishes power to another dynamo by the ordinary method of belting.

There is no complicated apparatus to get out of order.

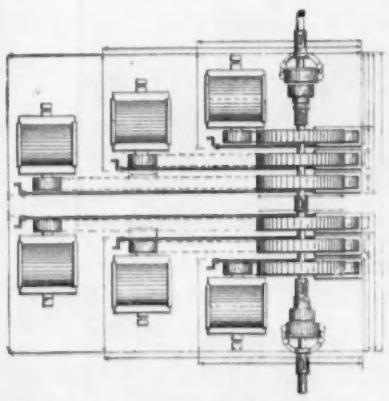


FIG. 2.—P. & D. DYNAMO COUPLING.

The idler is simply and strongly made and requires no attention. When it becomes necessary to enlarge the station three more dynamos can be added by increasing the length of the shaft by eight feet or six more by an increase of sixteen feet, which does not involve any radical change in the plant.

In this case the entire installation of the six dynamos and their driving pulleys and transmitters occupies a space of only 17 feet 2 inches × 20 feet 6 inches. This is a result which could hardly have been obtained by the system of belting now in general use and such economy of space is a strong point in its favor.

The Zell Water Tube Boiler.

The boiler which is represented here in perspective and sectional view belongs to the well known type of sectional water tube boilers whose distinctive claims to absolute safety from destructive explosion and consequent low insurance rates, rapid generation of steam and economy of maintenance and operation, have been well established by long experience. In addition to these general features the Zell boiler has some special points of excellence.

It is not suspended from a frame, as are many of this type, thus relieving the nippled joints from the weight of iron and water which intensifies the action due to the alternate expansion and contraction of the parts. It rests on two saddles placed under the mud drum *C* at the rear lower end, and on a roller *I* carried by the archplate *H* over the fire doors. There are no upright tubes in the path

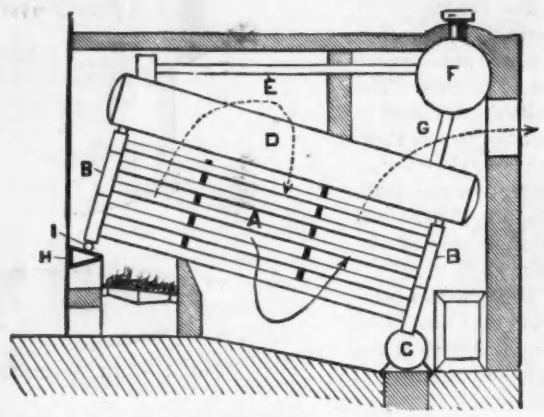


FIG. 1.—ZELL WATER TUBE BOILER.

of the hot gas at the rear end, through which the water circulation must be maintained downward in a direction opposite to that naturally taken by the steam. It is well known that when steam and water have to take opposed courses through the same pipe of small diameter that a steady circulation cannot be maintained. In the case of this type of boiler an interruption of the circulation means a solid deposit of scale where the flame is sufficiently hot.

The water drums, *D*, are placed parallel to the incline of the water tubes, *A*, and the feed water is introduced at the rear lower end of drum *D*, from which point it naturally descends into the rear headers *B*, to be distributed among the tubes. The greater part of the impurities will naturally be precipitated at once from the feed water, on its contact with the hot water in the boiler, and will collect in the mud drum below, and the balance will be deposited there by the succeeding passages of water through the rear headers, due to a rapid and free circulation. The boiler is thus, in a measure, its own purifier.

In comparison with other generators of its type, it is claimed that the water carrying capacity of the Zell boiler is considerably greater, particularly in those above 75 h. p., which have two drums.

The steam, after disengaging itself from the water at the upper end of the water drums *D*, passes into the superheating tubes *E*—a feature peculiar to this boiler—where any entrained water is evaporated, then passes to the steam drum *F*, which is supported by a water leg *G*, at each end connecting with the water drums, but well out of the path of the hot gases. The drum is exposed to the hot blast for about three-fifths of its own circumference, thus providing

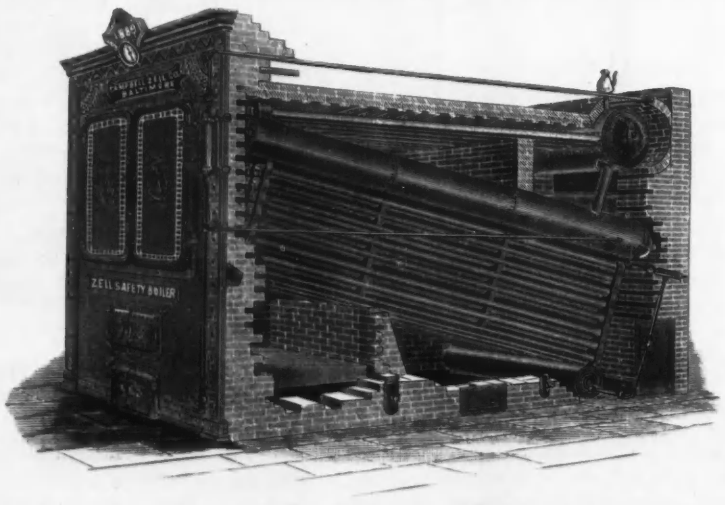


FIG. 2.—ZELL WATER TUBE BOILER.

additional superheating surface, and insuring perfectly dry slightly superheated steam. Each header *B* takes in four tubes, and has two handhold plates on the inside, closing under pressure, thus removing all danger from stripped threads or broken bolts, and insuring the fireman against being scalded. Every square inch of the boiler is accessible, and can be easily watched.

These boilers are very carefully built and the workmanship is excellent in every respect. The manufacturers claim a very high efficiency and economy, as well as perfectly dry steam. This boiler is manufactured by the Campbell & Zell Company, of Baltimore, Md.

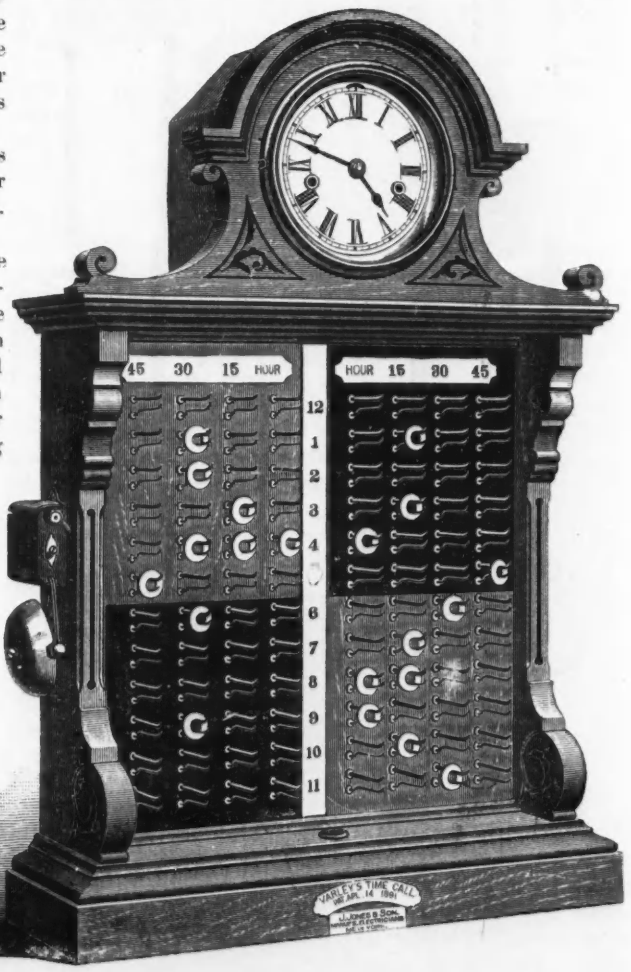
A Portable Lamp Stand with Flexible Arm.

In the accompanying illustration is shown a new form of lamp stand recently put upon the market by the McGeary Electrical Specialty Company, 136 Liberty street, New York. To a base of either polished brass or nickel is attached a flexible arm carrying the incandescent lamp. This enables the light to be placed in any desired position, which is a great convenience to the user. Over the lamp is placed an aluminium half shade, which can be moved around at will, so as to throw the light in any direction. Aluminium has been found to be an excellent material for this purpose, as it will neither break nor tarnish. Each one of these portables is also fitted with an attachment plug and 12 feet of silk cord.

PORTABLE LAMP STAND.

The Varley Electric Time Call.

Electricity has been put to many labor and time-saving uses and one of these is illustrated in the accompanying cut, which represents a time call recently brought out by J. Jones & Son, 39 Vesey street, New York. It is intended for use in factories, offices, schools and all places where punctuality is necessary, but perhaps it will be best appreciated by the hotel clerk. Beneath the clock which forms the stop of the apparatus is arranged a series of double pins which represent each hour and quarter hour of the day and night, the numbers on the centre strip denoting the hours, those across the top the quarters. If a metal ring is slipped over any pair of these pegs so as to electrically connect them, when the clock reaches the hour which those pegs represent the circuit is automatically closed and the bell at the side starts to ring and continues to do so until the metal ring or tag is removed. Suppose, for instance, that



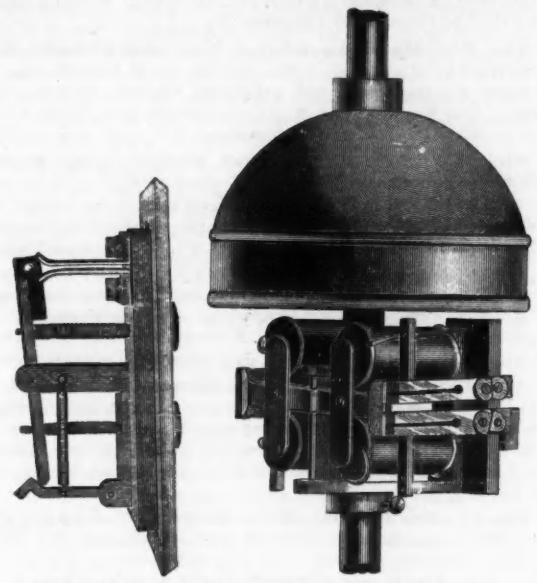
VARLEY ELECTRIC TIME CALL.

a guest at a hotel requests to be called at 6:30 A. M., instead of writing it down on his blotter and running the risk of making mistakes, the clerk simply slips a tag with the number of the room and perhaps a memorandum of the request over the pins opposite the hour designated. At the proper time the bell rings, and it is necessary for a bell-boy to actually remove the tag, which is so plainly marked that mistakes are practically impossible. Different colors or forms of tags might represent different forms of service required. The clerk is thus relieved of all responsibility of memory, and the proportion of annoying mistakes reduced to a minimum.

Painter's Chandelier Switch.

It is often a great convenience to control the entire lighting of a house or building by a single bank of buttons placed at some one point, provided that this does not prevent the control of individual lights or groups from other desired spots. To supply such a demand Mr. G. E. Painter, 217 N. Calvert Street, Baltimore, has recently placed several new forms of automatic switches upon the market. One of the best of these is an automatic chandelier switch, which is herewith illustrated.

This device consists of a yoke-shaped base with set screws to engage the pipe and a canopy which slips down and conceals the mechanism, as shown in Fig. 1. Upon this yoke



FIGS. 1 AND 2.—PAINTER'S LIGHTING SWITCH.

are supported two pairs of magnets operated by an open circuit battery and controlled by a compound push button, which is illustrated in Fig. 2. The main circuit is opened or closed by a rocking armature carrying a contact at each end, which is attracted by one or the other of the pairs of magnets. Two spring contacts, insulated from each other when in contact with the armature, form one side of the main circuit. The armature, whether in circuit or not, is always engaged by both sets of springs and remains in any one position until affected by the magnets.

As objectionable sparking would occur at these brushes and injure the lever contact, a delicate spring with platinum tips has been fastened to each brush which is last to separate from and first to make contact with the armature in the operation of the switch. This shunts the current for a short period, and does away with the sparking at the main contact points. Fig. 3 is a sketch of the circuits.

This switch is for 15 ampères, double poled, and provided with fuses. As only one tube and ordinary annunciator wires are required instead of the large mains in their separate tubes, both economy and convenience are claimed.

The Crolius Electric Light Bracket.

To quickly and easily wire an electric fixture is no light task under ordinary circumstances, and to facilitate this class of work the Globe Light and Heat Company, Lake street, Chicago, are placing on the market the Crolius electric light bracket, which we show in the illustration, that is not only simple and attractive in form, but, what is of more

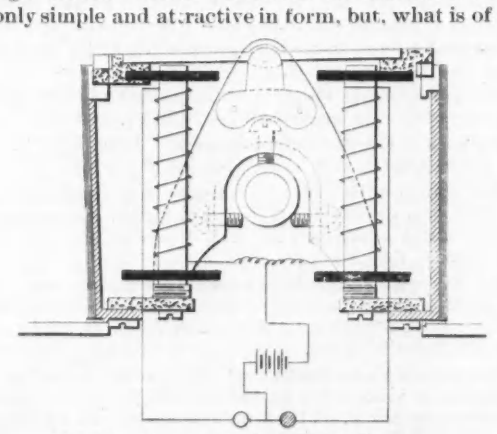


FIG. 3.—PAINTER'S LIGHTING SWITCH.

importance, can be wired in one-half the time required to wire the ordinary fixture, and this without damaging the lacquer. The illustration shows the mechanical details of the single bracket at a glance, the double bracket being similar in make-up.

The Hazleton-Ingersoll Electric Street Car System.

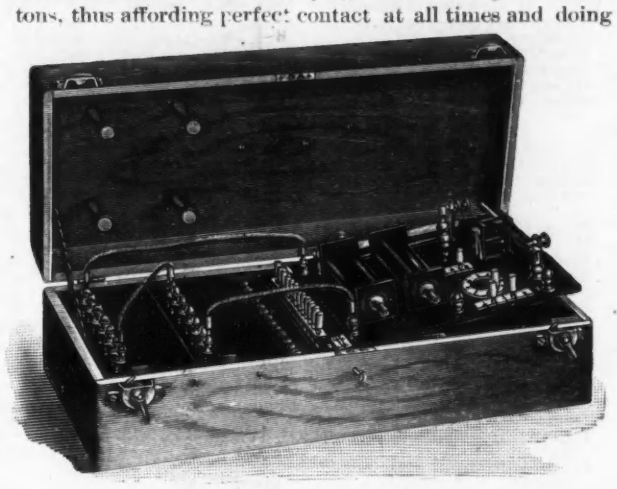
Mr. Elias Hazleton, of Lansing, Mich., is the inventor of a new system of street car propulsion. It is a conduit system, but differs in many particulars from any which has yet appeared. The conduit is very simple of construction, and very durable, consisting of two double T rails placed side by side, which rest on the ties and leave a slot about three-eighths of an inch wide at the top. The feed and return wires are placed inside a piece of grooved wood or plank which fits the outside recesses of the rails, the feed wire on one side, the return on the other. These wires are not only covered with insulating material, but are imbedded in a paraffine compound and surrounded by wood, so that a high tension current can be carried with safety. At intervals of about every 10 feet switches are connected to the wires, which pass through holes in the conduit rails and project into the conduit.

From each end of the car truck brackets or hangers are hinged which reach down through the slot and are connected by a strip of vulcanized fibre, or some flexible material, with a conductor on each side extending nearly the whole length of the fibre. Through this shoe sliding contact is made with the projecting switches, one coming on at the forward end of the car before the last one has left the rear end.

Under the lower slot of the conduit is a drain to carry off water or any foreign matter that may get in. Perfect insulation, absolute safety, small expense of installation and operation are points claimed in its favor. The system is in the hands of the Hazleton-Ingersoll Electric Street Car System Company, Lansing, Mich.

Sample's Physicians' Outfit.

A combined battery suitable for general office practice, yet made sufficiently portable to be used at the residence of the patient in case of emergency, is illustrated herewith and is being placed on the market by Mr. H. C. Sample, 145 Ontario street, Chicago. It has a capacity for 12 bichromate cells made of hard rubber and divided into two sections of six cells each. Brass switch plugs are used in place of buttons, thus affording perfect contact at all times and doing

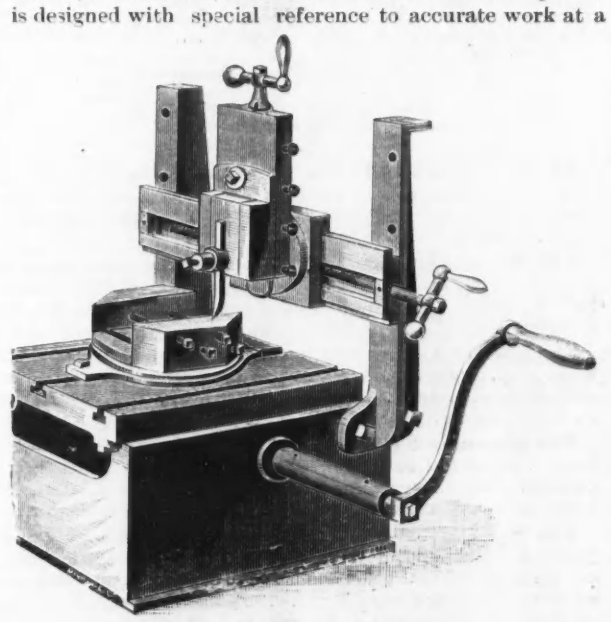


SAMPLE'S PHYSICIANS' OUTFIT.

away with interruptions caused by surface dust. It contains a rheostat of 3,000 ohms resistance suitably divided and cut in circuit by means of plug contacts; and in the case is ample room for all the necessary electrodes milliampère meter, etc. Mr. Sample has also placed a new form of the Pynchon throat electrodes on the market as well as new nasal electrodes to which the nasal tissues cannot adhere.

Shepard's Hand Planer.

The illustration shows an indispensable tool for the inventor, the amateur, and for schools and model shops. It is designed with special reference to accurate work at a



SHEPARD'S HAND PLANER.

good speed. A universal planer chuck is furnished with each machine. H. L. Shepard, of Cincinnati, O., is the manufacturer.

NEW BOOKS.

THE PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS. By Prof. F. B. Crocker and Dr. S. S. Wheeler.

This book is announced for early publication, as it is now in press. It will contain seven chapters treating upon the general principles of dynamos and motors, with directions for selecting, installing, starting, running, stopping, and testing machines of this kind, and will also have a chapter on locating and remedying faults in dynamos and motors.

L'ANNEE ELECTRIQUE ON EXPOSE ANNUAL DES TRAVAUX SCIENTIFIQUES DES INVENTIONS, ET DES PRINCIPLES APPLICATIONS DE L'ELECTRITE A L'INDUSTRIE ET AUX ARTS. By Ph. Delahaye. 8th year. 344 pp., ill. Baudry et Cie. Paris, 1892.

This handy little manual of the annual progress of the electrical sciences is the eighth year in the series compiled by the same author, and covers very completely the different branches of the electrical industries. The treatment of each individual subject is very concise and whenever necessary illustrations are given. The first chapter contains descriptions of apparatus relating to electric lighting, the second deals with primary and secondary batteries, the third and fourth with telegraphy and telephony, the fifth with atmospheric electricity, the sixth with medical electricity, while the subjects of electrolysis and electro-metallurgy are treated in the seventh, electric railways in the eighth, transmission of power in the ninth, and miscellaneous experiments and applications in the tenth. Brief obituary notices are given. Compilations of this kind are more often met with in foreign languages than in the English, and seem to have met with more favor in France and Germany than in this country and England. They are, however, very useful to those who wish a condensed account of the principal electrical developments of each year.

DYNAMO-ELECTRIC MACHINERY: A Manual for Students of Electrotechnics. By Prof. Silvanus P. Thompson. Fourth edition, enlarged and revised. 864 pp., 498 ills., 29 folded plates. Price, $9.00. E. & F. N. Spon, London. First notice.

Since our review of the third edition of this elaborate work in 1888 the whole science of electricity has been rapidly advancing. In order to be up with the times it has been necessary for the author to not only make corrections and additions, but to entirely rewrite almost every part of the former edition. So far as we have been able to examine the book it appears to be a very decided improvement upon the last edition. It is nearly one-third larger, the illustrations are more numerous and of better quality, and new chapters have been added treating of subjects which have become prominent during the last two years. It is obviously impossible without a more careful examination of this important work than we have been able to give it, to review in detail its treatment of the whole science of electrotechnics. We will therefore content ourselves for the present with giving our readers merely an outline of the contents and scope of the work.

After an introductory chapter some historical notes are given which will prove of great value in directing the student to original sources of information, for in the one brief chapter of 15 pages devoted to this subject no less than 115 references are given to papers in which the student may search for further information. The physical theory of dynamo-electric machines is then taken up and treated with the same fullness which characterizes this section of the third edition. Two chapters treat of armature actions and reactions. Then follows what is perhaps the most elaborate treatment which the book contains upon the subjects which Prof. Thompson rightly considers of fundamental importance in the study of dynamo-electric machines; to these subjects, namely, magnetic principles, the magnetic properties of iron, and the magnetic circuit, the author has given over 70 pages. After a short chapter on the forms of field magnets, the elementary theory of the dynamo in its various forms of magneto, separately excited, series and shunt machines, is then considered. The study of characteristic curves forms a separate chapter. Then follow five chapters which will perhaps be welcomed more than any other part of the book by students of dynamo design, on the winding and practical construction of armatures, the construction of commutators, brushes and brush holders, mechanical points in design and construction and the general treatment of the elements of dynamo design, including the calculation of windings. It is in this part of the book that the distinguishing features of this edition are principally found, as Prof. Thompson has aimed to set forth with special clearness the practical side of constructive electrical engineering. Three more chapters are given up to the descriptions of arc lighting dynamos of various types, modern continuous current machines, and others of a miscellaneous character. Two chapters deal with the theoretical and practical treatment of the electric motor of the continuous current type, and after the subject of alternating currents has been introduced by a statement of the fundamental principles, two more chapters are occupied with the study of alternating current dynamos and motors. Not the least interesting chapter in the book is that on transformers, which is taken up after the treatment of alternating current motors. The electric transmission of energy has not been treated to any very great extent, but the fundamental principles are clearly stated. The next chapter, on the regulators for dynamos, is very largely made up of what forms one of the appendices to the last edition, and this is also true of the chapter on the testing of dynamos and motors. Some practical instructions are given on the management of dynamos, and then follow two appendices, one of which is on the subject of electric and magnetic units and the other on wiring and wire gauges.

Every subject treated has been carefully brought up to date, and it is evident that Prof. Thompson has been a close student of current electrical literature. The book has already become such a standard one that every electrical engineer must of necessity be acquainted with its contents, since references to it occur so frequently in the periodical literature of the day. We are glad to find in this edition what is characteristic of all Prof. Thompson's books, namely, an elaborate index, which in this work covers no less than 44 pages.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, May 14, 1892.

Review of the Market.—Though the stock market this week has been active and with a decided upward tendency, still it does not yet show evidences of being one of those bull markets that will carry all stocks along to high figures, and bring weeks and months of activity for the exchanges. While the financial condition remains as it has been for so many months we cannot look for long continued activity in the stock market. The wisest prophets cannot foresee the end of this season of low prices. Saving banks and trust companies are putting their funds into good bonds, for they cannot stand the low money rates for ordinary loans. The bond market is moderately active, and at good figures. A real active bond market would bring out similar conditions of activity in the stock market, but as yet it is not sufficiently strong for that. London has recently bought more bonds than for some time past, and its transactions on our market have been very large. The usual tendency here is to follow the action of the London trading on our market; and the bulls and bears are active according as it sells or buys American securities. The money market is without any new feature, and rates are unchanged at 2 to 4 per cent. for call loans; and 3½ to 5½ per cent. for time loans. Money at the clearing houses is as low as 1½ per cent.

The electric stocks have had the best week for a number of months and almost without an exception have been strong and active. The quotations show advances in nearly every stock. They have led the market rather than followed the rise of any other stocks. Perhaps it is the announcement of the new officers of the General Electric Company that has inspired the public to buy Thomson-Houston and send it to such high figures. Those who have felt satisfied to hold the stock under the present efficient management no doubt consider it as desirable property with the same officials at the head of the new company. With larger resources at their command, and a broader field with less competition, they cannot fail to administer wisely the affairs under the new régime, and continually increase the value of all the property that comes under their immediate management. Thomson-Houston reached 67¼, the highest figure that it has sold at for over two years. Edison stock sold as high as 112⅛, which is the highest figure ever reached by that stock. The sales for the week amount to about 20,000 shares. At such figures as these the General Company's stock will open at quite a premium. At the beginning of the week Westinghouse seemed to show signs of weakness and lost 2 points, but later it regained them and closed quite strong at 30, with the preferred at 46. This week has actually passed without some new plan being offered for this company joining the consolidation. Fort Wayne has lost a point on account of the reduction in its rate of dividends. It has previously paid 75 cents semi-annually, a regular six per cent. rate; but the dividend payable on the 16th is only 50 cents. The reduction has brought out considerable comment, for the reason that when the Thomson-Houston company offered the stock at $12.50 the stockholders were assured of six per cent. dividends. All statements from the company have been to the effect that it was earning from 12 to 15 per cent., and in view of these statements no apparent cause can be seen for the company's inability to continue on a six per cent. basis. The opinion seems a reasonable one that this change in rate is indicative of terms by which the company will join the consolidation. Twelve and a half for the stock, or even 15 and a guarantee of four per cent., would make it a good investment. This looks more reasonable now than our figure of 20, which we quoted last week. The Thomson-Houston International Electric Company joins the ranks of the General Company at 240 for its common stock and par for preferred. This is on a basis of twelve shares of the new stock for five of the old common; and share for share of the preferred. Since the latter pays seven per cent. regularly, it will probably have the same guarantee from the General Company.

Offerings of Electric Bonds.—Lee, Higginson & Co., of Boston, include in their regular monthly circular, offering bonds, many electrics, together with their regular railroad bonds, including United Electric Securities Company bonds, fourth series, five per cent. gold collateral trust bonds; series limited to $500,000, secured by $627,500 first mortgage bonds of local electric light and railway bonds, price 95 and accrued interest. Also fifth series of same company's bonds. This series is limited to $1,000,000, secured by $1,250,000 collateral bonds, price 93 and interest. Also New England Telephone & Telegraph Company's six per cent. bonds. This is the fourth issue of bonds, each of $500,000, due 1907, price 105½ and interest. Also Northwest Thomson-Houston Company preferred eight per cent. cumulative stock, total issue, $750,000, dividends payable March 15, June 15, Sept. 15 and Dec. 15, price 110 and accrued dividend.

Westinghouse Electric.—Recent estimates made by those familiar with the present increasing business of the Westinghouse Company, based upon the outlook for this year's earnings, calculate that if the company shall earn this year $4,000,000 gross, although it is estimated it will reach $6,000,000, and allowing 20 per cent. for the net income, there will be left, after deducting all charges, $560,000 applicable to dividends, or about 9½ per cent.

Chicago Arc Light and Power Company.—The report of this company at its annual meeting, May 9, showed net earnings of £87,033. Owing to the serious effects of the fire some months ago, the surplus of the company was absorbed and the capital impaired to the amount of $28,791.

The United Electric Securities Company, of Boston, has just issued its eleventh call, inviting proposals for sale to the company of $30,000, $40,000 and $80,000, second, third and fourth series, respectively, of its five per cent. collateral trust sinking fund bonds. Sealed proposals will be received at the company's office, 180 Summer street, Boston, until 12 o'clock noon, May 20, 1892. All bonds accepted will be paid May 21 with interest accrued to that date.

The Erie Telegraph and Telephone Company's balance sheet of March 31, 1892, is as follows:

ASSETS.

Stocks	$4,996,155
Unissued stock	200,000
Cash for unpaid dividends	1,337
Dividends due	76,035
Accounts receivable	5,203
Cash	7,095
Total	$5,285,826

LIABILITIES.

Capital stock	$5,000,000
Unpaid dividends	1,337
Surplus	101,488
Reserved for dividend No. 34	48,000
Notes payable	135,000
Total	$5,285,826

West End Railway stock has had quite a remarkable rise this week—remarkable when it is remembered that 2,000 shares of the common stock have been sold every day at steadily advancing figures. The preferred stock rose in sympathy three points above its usual place. The sales this week are as follows:

Date.	No. of shares.	Rate.	Amount.
May 9	2,000	$73.53	$147,062.50
May 10	2,000	75.01	150,025.00
May 11	2,000	75.44	150,887.50
May 12	2,000	74.43	148,868.75
May 13	2,000	74	148,000.00
May 14	2,000	74.18	148,262.00
Total, 12,000 shares			$893,105.75
The same if sold at par			60,000.00
Premium realized			293,105.75
Total sales of shares to date			24,000
Aggregate realized			$1,769,612.00
Par value			1,200,000.00
Premium			559,612.50

Increase in Capital Stock.—The new electric light company recently organized at Newport, R. I., has increased its capital stock from $50,000 to $150,000. The Western Electric Light and Power Company, of Toledo, O., has certified to an increase in capital stock from $20,000 to $200,000. The Bell Telepone Company of Canada has been authorized by act of the Dominion Legislature to increase its capital stock to $5,000,000. The company desired bonding powers equal to the amount of the authorized stock, but this was refused, and its powers confined to the $500,000, which it now possesses.

Dividends.—The Erie Telegraph and Telephone Company has declared a dividend of one per cent., payable to stock of record May 16. The directors of the Fort Wayne Electric Company have declared a semi-annual dividend of 50 cents per share, payable on May 16.

Closing Quotations.—The following were the closing quotations of electric stocks, on Saturday, May 14, 1892, in New York and Boston:

NEW YORK QUOTATIONS.

Name of Stock.	Par.	Capitalization.	Bid.	Ask'd.
American Cable	...	.....	84	85
American Telegraph Co.	100	14,000,000	60	63
Western Union Telegraph Co.	100	86,200,000	92¾	93
Commercial Cable Co.	100	7,716,000	155	160
Edison General Electric	100	15,000,000	101½	111½
Edison Illuminating Co., of New York	100	4,500,000	79½	80
" " " Brooklyn	100	750,000	76	80
" " " Chicago	100	750,000	138	142
U. S. Illuminating Co.	100	1,250,000	30	35
Edison Elec. Light Co. (of Europe) stock	100	2,000,000	2½	5
Edison Elec. Light Co. (of Europe) bonds	sh	30,000	65	75½
" Ore Milling Co	100	2,000,000	15	20
" Toy Phonograph Mfg. Co	10	1,000,000	....	½
Brush Illuminating Co., of New York	50	1,000,000	40	50
Mt. Morris Electric Light Co.		500,000	20	40
East River Electric Light Co.	100	1,000,000	...	60
North American Phonograph Co.	...	6,500,000	5	8
New York Phonograph Co.	...	2,000,000	3	4
Automatic Exhibition Co.	...	2,000,000	3	6
New England Phonograph Co.	...	2,000,000	1¾	2¾

BOSTON QUOTATIONS.

	Par.	Capitalization.	Highest.	Lowest.	Bid.	Ask'd.
Thomson-Houston Elec	25	6,000,000	67¼	64	66⅝	66¾
Thomson Houston Elec. preferred	25	4,000,000	30¼	29⅛	30⅛	30¼
Thomson-Houston Elec.—Series C	sh	40,000	8⅞	....	8½	9
Thomson-Houston Elec.—Series D	sh	120,000	7¼	....	7	7¼
Thomson-Houston Int'n'al Elec.	100	600,000	....	....	....	244
Thomson-Houston Int'n'al Elec—Pfd.	100	400,000	....	....	103	105
Thomson Elec. Weld.	100	1,000,000	....	....	...	....
Thomson European Elec. Weld	100	1,500,000	....	....	10	15
Westinghouse Elec.—New Com.	..	6,000,000	30	28	29½	30
Westinghouse Elec.—Pfd.	..	4,000,000	46	45	45½	46½
" " Trust receipts	..	10,000,000	....	....	....	....
Fort Wayne Elec.	25	4,000,000*	13⅜	12¾	12¼	12½
Fort Wayne Elec.—Ser. A.	sh	80,000	7⅝	7½	7¼	7½
Detroit Elec	10	1,000,000	....	....	....	....
West End St. Ry. Co.—Com	50	7,150,000	76	72½	74	74⅛
West End St. Ry. Co.—Pfd	50	6,400,000	89¾	86½	88	89
American Bell Tel	100	15,000,000	209½	205	206	207
Erie Tel. & Tel. Co.	..	4,800,000	45½	46½	46	47
Mexican Tel. Co.	10	1,280,000	102½	....	100	110
New Eng. Tel. & Tel. Co.	..	10,304,600	53	52	52	53
Tropical Tel. Co.	10	400,000	....	....	52	30

*Ex dividend.

NEW INCORPORATIONS.

The Commercial Electric Light Company, of Columbus, Ind., capital stock $20,000, has been formed to generate and use electricity for power and illumination. Levi J Lehman, A. Strauss and H. A. Essix are the promoters.

The Moscow Electric Light and Power Company, of Moscow, Idaho, capital stock $50,000, has been formed to furnish light and power, and to construct a street railway. M. J. Shields, P. Tillinghast and J. H. Shields are the promoters.

The Liberty Avenue Street Railway Company, of Pittsburgh, Pa., capital stock $50,000, has been formed to operate an electric street railway. S. J. Wainwright, Jr., M. F. Leslie, and P. C. Byrne, of Pittsburgh, Pa., are the promoters.

The Hammond Electric Railway Company, of Hammond, Ind., capital stock $100,000, has been started to construct, own and operate street railways, etc. Miner Wamsley, Chas. M. Story, Harry Wurzburger and Jos. M. Finn are the incorporators.

The Western Electro-Therapeutic and Alarm Company (incorporated in West Virginia), of Washington, D. C., capital stock $500,000, has been formed to deal in electro-alarm and electro-therapeutic apparatus, etc. The promoters are A. J. Curtis, A. T. Smith, Washington, D. C., and J. Y. Williams, of St. Paul, Minn.

The Korsmeyer Plumbing and Heating Company, Lincoln, Neb., capital stock $27,000, has been incorporated to deal in plumbing appliances, electric light fixtures, etc. F. A. Korsmeyer, G. W. Wentz and N. H. Howard, of Lincoln, Neb., are the incorporators.

The Tamaqua & Pottsville Electric Railroad, of Tamaqua, Pa., capital stock $120,000, has been formed to construct and operate an electric railway in Schuylkill County, Pa. J. O. Ulrich, John H. Stidfole and Wm. J. Oliver, of Tamaqua, are the promoters.

The National Construction Company (incorporated in West Virginia), of New York City, capital stock $1,500,000, has been started to build electric and other railways, etc. W. J. Foster, M. C. Steinrich, of New York City, and E. W. Summex, of Brooklyn, are the organizers.

The Lewistown & Bellefonte Electric Railway Company, of Lewistown, Pa., capital stock $400,000, has been formed to construct and operate an electric railway in Bellefonte, Pa. The organizers are Johnson Muthersbaugh, A. P. Martin and W. W. Trout, all of Lewistown.

The Dewey Electric Heating Company (incorporated in West Virginia), of Syracuse, N. Y., has been incorporated with a capital stock of $200,000, for the purpose of manufacturing and selling electric apparatus, etc. Emil Laass, Chas. H. Duell and M. W. Dewey are the parties interested.

The Van Choate Electric Car and Light Company, of Portland, Me., capital stock $6,000,000, has been incorporated to manufacture and deal in electrical appliances of all kinds, etc. C. Henry Kimball, Chelsea; Oscar Lowe, Boston, and Edward B. Hill Brookline, Mass., are the organizers.

The Wichita Falls Electric Light and Power Company, of Wichita Falls, Tex., capital stock $30,000, has been organized for the purpose of supplying electric light and power. D. J. Calkins, W. C. Heath, A. Zundelowitz and J. A. Kemp, all of Wichita Falls, are the incorporators.

The Susquehanna Railway Company, of Susquehanna, Pa., capital stock $75,000, has been formed to construct and operate an electric railway in Cumberland county, Pa. The persons interested are C. Eberle, Girardville, Pa.; M. Walsh, Beaver Falls, Pa., and Geo. R. Graham, of Allegheny, Pa.

The Phœnix Consolidated Gas and Electric Light Company, of Denver, Colo., capital stock $300,000, has been formed to manufacture and supply to any city or town electric lights, etc. Frank Evans, A. Albert Abrams and Chas. F. Musgrove, all of Denver, are the organizers.

The Rochester and Beaver Electric Street Railway Company, of Beaver, Pa., capital stock $60,000, has been formed to operate a street railway from Bridgewater to Rochester. Thos. Darragh, of Rochester, Pa.; Alfred C. Hurst, of Bridgewater, Pa., and Almond R. Leyda, of Beaver Falls, Pa., are the organizers.

The Columbus Street Railway Company, of Columbus, O., capital stock $3,000,000, has been formed to construct and operate a street railway in Columbus, which will use electric or other motive power. Philip H. Bruck, Edward Denmead, Irvin Butterworth, C. P. L. Butter and Chas. G. Lord are the incorporators.

The Jordan Electric Train Signal Company, of Portland, Me., capital stock $150,000, has been incorporated for the purpose of manufacturing and selling signals and all devices for such and all apparatus connected therewith. Henry B. Burnett, Frank D. Rogers and Herbert A. Clay, of Portland, Me., are the incorporators.

The Lynden Electric Motor Railway Company, of Lynden, Wash., capital stock $250,000, has been formed to build and operate railroads, etc. W. N. Lawrence, Dr. Walter Wilbur, H. A. Judson, E. J. Robinson, S. Kildall, E. Edson, P. C. Williams, S. H. Bradley, Alfred Keohan and B. W. Loring, all of Lynden, are the corporators.

The Cardarelli Electric Light Crane Company, of Sumter, S. C., capital stock $6,000, has been incorporated to manufacture and sell electric light cranes under the Cardarelli patent in certain States. The organizers are: H. J. Harby, R. M. Wallace, E. Cardarelli, Chas. T. Mason, Jr., and Horace Harby, all of Sumter, S. C.

The Nagaunee & Ishpeming Street Railway and Electric Company, of Negaunee, Mich., capital stock $120,000, has been formed by the consolidation of the Negaunee & Ishpeming Street Railway Company and Negaunee & Ishpeming Electric Light Company. Alexander Maitland, John B. Haas and Peter White are the incorporators.

The Haverhill & Amesbury Street Railway Company, Haverhill, Mass., capital stock $250,000, has been organized to construct a street railway, to be operated by any power except steam, and connecting Haverhill, Merrimac and Amesbury. Chas. Goss, Dudley J. Marston, Wm. G. Ellis, A. W. Goss, Adam Scott and N. Emory Collins are the promoters.

The Columbus and Magnetic Springs Electric Railway Company, of Magnetic Springs, O., capital stock $25,000, has been organized to construct an electric road between Magnetic Springs and Columbus, and to supply light, heat and power. The promoters are Edwin R. Hotsenpiller, Dunbar C. Kilbury, Jno. W. Newhouse, Wm. M. Miller and Solomon Hill.

The Arnold Novelty Company (this company succeeds the Arnold Novelty Company of same place), of Tacoma, Wash., capital stock $12,500, has been formed to buy and sell electrical appliances and especially the Arnold electrical flexible brackets, etc. A. F. Esperson, W. S. Arnold, J. E. Small, S. L. Rau, Richard W. Kimball, and F. W. Hicks, of Tacoma, are the incorporators.

AFFAIRS OF THE COMPANIES.

The Erie Telephone Company will hold its annual meeting in New York on June 14.

The City Electric Railway Company has filed a certificate of change of location from Ottawa to Peru, Ill.

The Charlotte Electric Company, of Charlotte, Mich., has sold its plant, it is stated, to W. P. Engel, of Chicago.

The Minersville Electric Light Company, of Minersville, Pa., has elected the following directors: Joseph Gerz, F. C. Bender, Matthew Beddow, Dr. Wm. F. Kistler, Henry Laudeman and Frank G. Kear.

The Reno Electric Light and Power Company, of Reno, Nev., held its annual meeting recently and elected the following trustees: C. C. Powning, C. T. Bender, W. O. H. Martin, M. D. Foley and Evan Williams.

The Brush and Cincinnati Electric Companies, of Cincinnati, O., at a recent meeting of the directors elected Gen. Hickenlooper president; C. F. Hesser, vice-president; H. Ryland, secretary, and C. F. Faust, treasurer.

The Campbell Electric Supply Company, of Boston, held its annual meeting recently at Manchester, N. H. The following were chosen directors: R. A. Stewart, F. A. Spooner, M. A. Blaisdell, H. F. Campbell, J. A. Jackson and J. A. Emery. A meeting will be held in Boston for the purpose of organization.

The Ashland Gas and Electric Light Company, of Ashland, O., at its recent annual meeting elected the following directors: G. A. Ullman, E. A. Potter, S. H. Grabil, J. E. Swartz, T. M. Beer. The directors organized by electing E. A. Potter, president; G. A. Ullman, treasurer; J. E. Swartz, secretary and general manager.

The East Tennessee Telephone Company at its recent annual meeting at Bowling Green, Ky., elected the following directors to serve for one year: John M. Brown, S. J. Keith, James Compton, O. F. Noel and M. M. Gardner. The officers submitted a statement of the company's business for the fiscal year ending March 31, which showed highly satisfactory results.

Receivers Appointed.—Judge Ingraham, in the New York Supreme Court on May 11 appointed John Rooney receiver of the American Electric Light Company in proceedings for the voluntary dissolution of the concern. The order dissolving the company has been signed. Horace Poole has been appointed by the United States court receiver of the Allen & Swiney electric railway of Dubuque, Ia.

The Louisiana Electric Lighting Company, of New Orleans, La., at its recent annual meeting elected the following officers: Brainard Rorison, president; Joseph Simon, vice-president; F. S. Neustadtl, secretary and treasurer. The company closed a contract recently with the city of New Orleans for the lighting of its streets at $127.50 per annum for each lamp. The contract covers a term of ten years, and about 1,500 lights will be required.

Newport, R. I.—The new electric light company recently organized has elected the following directors: Theodore A. Havemeyer, Frederick W. Vanderbilt, Robert Goelet, Louis L. Lorillard, Augustin C. Titus, Gardner B. Reynolds and Henry H. Fay. The directors have elected Theodore A. Havemeyer, president; Gardner B. Reynolds, treasurer, and H. W. Darling, secretary. The original capital stock has been increased, referred to elsewhere in this issue of THE ELECTRICAL WORLD.

The Electric Railway Company of the United States will hold a special meeting of its stockholders at the office of the company, 1 Broadway, New York, on Thursday, June 9, for the purpose of electing nine trustees to serve for the year ending May 1, 1893, also three inspectors of the next ensuing election, and to consider and act upon the resolutions passed by the Board of Trustees on the 10th day of May, 1892, and to transact such other business as may come before the meeting.

The General Electric Company.—The headquarters of the General Electric Company are established under the law at Schenectady, N. Y., but it is stated the general direction of the company will be from 620 Atlantic avenue, Boston. The new issue of bonds will, it is understood, be upon pledge of the Thomson-Houston and Edison stocks. The General Electric Company will make contracts with the Thomson-Houston and Edison companies to become selling agents of electrical apparatus until the consolidation of all the interests can be effected.

The Chicago Arc Light and Power Company held its annual meeting recently and re-elected the old board of directors and officers. The financial report of the company referred to elsewhere in this issue of THE ELECTRICAL WORLD showed larger net earnings than had been expected in view of the serious effects of a fire some months ago, which absorbed the company's surplus and impaired its capital to some extent. In fact it cost the company $96,153, it is stated, with many thousands more through inability to care for business which it could have got. With the new factory in operation, more contracts being offered and all conditions favorable, the president of the company predicts a favorable year.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-176 TIMES BUILDING, NEW YORK, May 16, 1892.

The Fort Wayne Electric Company's New York office, H. C. Adams agent, is now located at 42 and 44 Broad street.

S. A. Day, manufacturer of Kerite insulated wires and cables, has removed his office from 16 Dey street to the new *Mail and Express* building, room 310, 166 Fulton street, this city.

Mr. T. W. Warfield has been appointed district manager of the Detroit Electrical Works, manufacturers of electric light and street railway power machinery and general electrical supplies, and has opened offices at room 311, 18 Cortlandt street, this city.

John G. Kihm, manager of the Western Union Telegraph Company's offices at Castle Garden, the Barge Office and Ellis Island, died Wednesday morning last at his home, 52 Ravine avenue, Jersey City Heights. Mr. Kihm was an expert linguist, and was able to converse with almost all of the various immigrants with whom he came in contact.

Master Electrician Wanted.—The position of master electrician is to be created at the Brooklyn Navy Yard under the Bureau of Equipment. Examinations for the appointment are to be held May 31 at Brooklyn, and will be open to all comers who are citizens of the United States and can give evidence of some experience in the line of work required. The salary will be $6 per day.

The Waddell-Entz Electric Company has secured the contract for the complete generator and motor equipment for the new building of the *Mail and Express*. This plant, which will embody all the recent improvements in electrical machine design, will comprise 300 h. p. in generators and 19 motors from 40 h. p. down. The generators will be "direct coupled." Four 75 h. p. horizontal engines will be used. It will be one of the most complete electrical plants in this city.

Mr. J. Paul Gaylord, long a well-known central station manager in the South, has been elected president, and Mr. Lewis R. Schultz, also a well-known electrician and central station superintendent, treasurer of the Pennsylvania Electric Engineering Company, whose offices are located in the Penn Mutual Building, Philadelphia. Both gentlemen were in New York last week greeting many old friends.

Prize Essay on the Transmission of Power by Electricity.—We are informed by Prof. F. B. Crocker that a prize has been offered by an alumnus of the School of Mines of Columbia College of one hundred dollars for the best essay on the above subject that may be presented by a graduate of the school. The essays must be sent to Prof. W. P. Trowbridge on or before Nov. 1, 1892. President Seth Low will appoint a committee to examine the essays and award the prize. The successful essay will be published in the *School of Mines Quarterly*.

Mr. F. W. Harrington, well known in the electrical field, formerly with the Tropical American Telephone Company and the Western Electric Company, has left New York for San Francisco, Cal., where he will represent an electrical company in that territory. Mr. Harrington on Wednesday evening last was given a farewell send off by his friends and brothers of Ohio Branch lodge of the order of Odd Fellows at 145 West 125th street, this city. Olive branch lodge numbers in its membership a large representation in the electrical business, and the boys were out in full force to smoke and drink to the good health of Brother Harrington, who was treated to a surprise in the presentation on behalf of the lodge of a handsome gold Odd Fellow's pin. The evening was a most enjoyable one.

The Mount Morris Electric Light Company, of this city, had the contract for lighting the grounds and buildings of the United States Horse and Cattle Show Society at 155th street and 8th avenue during its recent exhibition. About 150 incandescent lights were installed in the club house on the society's grounds and 92 arc lights in the horse stalls and grand stands around the quarter mile track. Unfortunately an accident happened to the judges' stand, which was located in the centre of the field, on which there had been arranged and placed arc lights, so as to thoroughly light the inner field area. This stand was blown down just previous to the opening of the show, and therefore it became necessary to erect 12 special arc lights along the front of the open area. The grounds have been sufficiently well lighted, so as to allow the judging and exhibition at night, and it is believed will prove a popular resort at the semi-annual exhibitions of the society. Late Saturday night the company was ordered to light the streets and avenues approaching the entrances to the grounds at 155th street, and had the lights in position ready to light the approaches on the next night (Monday). This lighting could not have been done by gas or otherwise than by electric light in the very short time given to get the lights in position.

L. H. H.

ALBANY, N. Y., May 14, 1892.

Amsterdam has decided to raise $7,000 for a fire-alarm system.

Work on the electric light plant at Waterford will be begun at once.

The village of Green Island has decided to change the system of street lights from naphtha lamps to electricity.

The Electric Light and Power Company, of Hoosick Falls, is meeting with good success in disposing of enough stock to enable it to locate a manufactory for steam rollers and centrifugal pumps and utilize some of the splendid water power it has.

The report of the Albany Railway for the quarter ending March 31, which has been filed with the State Railroad Commission, shows: Gross earnings, 1892, $59,621; 1891, $45,077; operating expenses, 1892, $38,637; 1891, $46,610; other income, $268; fixed charges, 1892, $12,212; 1891, $8,022; net income, $9,040; deficit, 1891, $9,551. The balance sheet profit and loss surplus is $2,544.

A New Electric Canceling Machine will soon be in use in the Troy post office. An effort was made to secure power from the Troy Electric Light Company, but the company refused to make any contract unless a Baxter motor was used. It was decided to place a water motor in the post office to operate the machine, and the work will be done by the Ross Valve Company.

Mayor Manning, in his recent admirable message to the Common Council, thus speaks of the electric railways: "The spirit of the age is the spirit of rapid transit, and it is an indispensable condition of municipal development that the suburbs and outlying districts of a city be practically united with its business centre by the encouragement of rapid communication. Albany has every reason to be proud of its achievements in this direction. Only a few years ago the over-worked car horses were dragging their heavy loads up State street hill at a snail's pace; to-day every section of the city may be speedily reached by well-equipped electric lines. This city was among the first to adopt electricity as a motive power; and in view of the fact that many other cities, as Detroit, for instance, are still merely agitating this question of rapid transit, Albany may well claim a recognition of its newly awakened spirit of progress."

Saratoga, N. Y.—There was a new and vigorous departure in the Saratoga electric street railway matter when Justice Kellogg issued an injunction from the Supreme Court restraining the Saratoga Street Commissioners and all other persons from interfering with the construction of the company's street railway track and erecting trolley poles in Lincoln avenue from Ballston avenue to the racecourse. Immediately a force of over 100 men were put at work and the road completed. The incorporators and stockholders of the company as shown by the articles of incorporation are Henry Russell, C. E. Arnold, E. J. Slattery, A. J. Voyer, M. Nussbaum, C. D. Gregory, H. L. Smith and A. S. Pease, of Albany; L. H. Cramer, W. H. Bockes, H. Tompkins, C. S. Grant, W. W. Worden, F. Tarrant, M. Guiltinan, G. W. Morton, R. F. Knapp, F. H. Hathorn, B. J. Goldsmith, H. L. Waterbury, H. Smith, C. O. Van Dorn, G. R. P. S. Shackelsford, G. I. Humphrey and Willard Lester, of Saratoga Springs, and W. J. Arkell, of Canajoharie.

Johnstown, N. Y.—The people of Johnstown are wondering whether they are to enjoy the pleasures and conveniences of an electrical railway or two or three of them. A meeting of the directors of the Cayadutta Electrical Railway was held recently, and the maps of the proposed route were submitted to the board. A large amount of stock has been subscribed, over $11,000 worth being secured within a few hours after the meeting. The other roads are hampered in various ways. The passenger line will pass through Market street, the very centre of the town, while the line of freights will pass around the village on the east. It expects to haul the freight cars from the Central over its road with motor cars specially built for the purpose. Gloversville will be reached on the east near the old fair grounds. The officers of the company will be at Gloversville. The surveyors have about finished their work and soon a large force will be employed to push the road to completion, while the other lines are wrestling with their difficulties. The Fulton and Montgomery county road is another prospective road. The horse railway is endeavoring to have its motive power changed from horse to electricity. A special act has come to light that prohibits the horse railroad from using any other motive power than animal power. It is understood, however, that the horse railroad company will push ahead with the work already begun on its road notwithstanding the law, though it is sure to meet with active opposition in the courts from the other electrical railroads. Some large stockholders in the horse railroad who were opposed to the proposed change will themselves secure an injunction to restrain the company from carrying out its plan. In the meanwhile the Cayadutta and the Fulton and Montgomery county roads will be busy.

R. V. T.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 28, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., May 14, 1892.

The Ashton Valve Company, of Boston, is manufacturer of the celebrated Ashton valve, which it claims to be unequaled for efficiency and durability.

Massachusetts Electrical Engineering Company, of Boston, makes a specialty of expert examinations, testing, etc., and reports business in its line as being very encouraging.

The Boston Board of Fire Underwriters has issued a neat little pamphlet containing the rules and regulations for the installation of electric lighting and motive apparatus. It is dated May 1 and supersedes all previous issues.

The American Circular Loom Company, manager of the Canvas Jacket insulated wires and cables, reports that many of the best plants in the country are now using this product, and business for the last month has been decidedly on the increase.

The Porter-Leavitt Electric Motor Company, of Providence, R. I., is manufacturing its fan and battery motors in four regular sizes, and makes them a specialty. They are employed principally for sewing machines, dental drills, jewelers' lathes and all kinds of light machinery.

The Cambridge Board of Aldermen has adopted an order authorizing the West End Street Railway Company to use the trolley system over the Harvard bridge, providing that the company agrees to substitute a different system of motive power at the suggestion of the Aldermen.

The American Electric Company, manufacturers of the New Era electric gas lighting, bases its claims for popularity on account of the following merits: Absolutely safe from danger of leaking gas; simple and perfect mechanism; never fails to light; cannot strain the most delicate fixture.

The Simplex Electric Company, of Boston, is meeting with an active demand for its Simplex caoutchouc wire, and the report of the committee on underground conduit and wires, read at the recent meeting of the National Electric Light Association, contains a flattering reference to the most efficient wire.

The Standard Thermometer Company, of Peabody, Mass., manufactures electrical indicating and recording instruments, for use principally in electric light and power stations. They work admirably, continuously indicating and recording at one or more points changes of temperature, steam, water or gas pressure.

The Washburn & Moen Manufacturing Company, of Worcester, Mass., are extensive manufacturers of iron, steel and copper wire, and since the introduction of the electric telegraph and telephone service their patent wire, manufactured expressly for electrical purposes, has filled every requisition as regards strength, uniformity and conductivity.

The Electric Forging Company, of Boston, is advised that on May 17, 21 patents will be issued to the company. The company now owns 30 patents, and as many more applications are now pending. None of these, however, are fundamental patents, and do not command any such exclusive ownership of the forging and welding process as the Thomson Electric Welding Company has.

J. Bradford Sargeant reports a growing demand for the Sterling water tube safety boiler. This boiler is made on entirely new principles, some of the chief features being that the heating surfaces are thin and clean, and so placed as to be passed and enveloped by the gas currents in such a manner as to utilize all their heat energy. It is durable and economical, and only the best material is used in its construction.

The Thomson-Houston Company has 1,800 operatives in its railway department at the factory in Lynn, Mass., carrying a weekly pay-roll of $40,000. The company shipped 158 motors during the first week in May. The total number of roads in operation and under contract with the Thomson-Houston company April 1 was 230, against 211 Jan. 15. The total number of cars in operation under said contracts April 1 was 4,569, against 3,406 Jan. 15. The company is now making the largest switchboard ever built, it is stated. It is of marble, and is for the station of the Narragansett Electric Light Company, of Providence, R. I. It is 18 feet long and 10 feet high. It has plugs for 40 arc circuits, and is made up of 3,500 pounds of marble, 1,793 pounds of brass, 6,400 brass bushings, 9,300 brass nuts, 1,995 steel bolts, 6,040 brass washers, 3,040 rubber bushings, 3,200 rubber buttons, 2,000 brass screws, 3,400 brass connections, 320 brass binding posts, 640 feet of copper wire, 80 contact plugs and eight cast-iron standards. It will be completed within a month.

W. R. W.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, May 14, 1892.

Mr. B. M. Downs, representing William Brookfield, of New York, was a Chicago visitor this week.

Mr. B. J. Arnold, the well-known Thomson-Houston railway expert, is paying a flying visit to friends in Little Rock, Ark.

Col. L. W. Burnham, of the Electric Gas Lighting Company, of Boston, was entertained this week by his Chicago representative, Mr. C. E. Lee.

Mr. C. H. Decker, vice-president of the Decker Electrical Novelty Manufacturing Company, of Detroit, received some nice orders for electric bells in Chicago this week.

Mr. Charles E. Sharp, formerly treasurer of the Western Electrical Supply Company, of Omaha, is now manager of the South Western Electrical Supply Company, of St. Louis, Mo.

The electric railways and electric light companies of La Salle, Ill., are heavy losers by the recent floods in that section. The loss to both companies will amount to about $7,500.

T. C. White & Company, the well-known dealers in electric railway supplies, have moved from the Bank of Commerce Building to more commodious quarters on the ground floor of 805 Locust street, St. Louis, Mo.

The Bryant Electric Company, of Bridgeport, Conn., has opened an office in Chicago and has placed Mr. Thos. G. Grier in charge. Mr. Grier will hereafter represent this enterprising company in this territory.

The Central Electric Company reports very active business in the Interior Conduit and Insulation Company specialties, a great many of the large buildings being equipped with this conduit in Chicago and elsewhere.

The Railway Equipment Company will make its office and store room pending the fitting up of its new and permanent quarters at No. 11 Adams street, which location is well known as the former headquarters of the Electric Merchandise Company.

Not Killed by Electricity.—It was reported by the Associated Press last week that James Grant, of Chicago, was killed by electricity while holding a telephone receiver to his ear. Later reports show that the man did not receive any shock, and that his death, which occurred three days later, was the result of natural causes.

An Electric Carriage.—President J. B. McDonald and Secretary Harold Sturges, of the American Battery Company, 177 La Salle street, Chicago, enjoy daily rides in the luxurious carriage they have fitted up and which is supplied with current from improved Planté cells.

The Brush Electric Company has recently removed its Chicago offices from its old quarters at 225 Dearborn street to the new Monadnock Building, corner Dearborn and Jackson streets, where a suite of seven offices has been taken in the front of the building facing Jackson street.

Mr. William H. McKinlock, the founder and president of the Southern Electrical Supply Company, has just returned from St. Louis, and reports the Southern as doing a very brisk business, and says that under the new management the prospects for enlarged future trade are very encouraging.

Railway Telegraphers Convention.—One hundred and fifty members of the Order of Railway Telegraphers passed thruogh Chicago this week on their way to the sixth annual convention at Chattanooga, Tenn., and during their stay in the city were shown over the Exposition grounds. This society is a combination of the Brotherhood of Telegraphers and the Order of Railway Telegraphers, and has now about 30,000 members. Its object is to protect its members against the large telegraph and railroad companies.

Prof. J. P. Barrett, city electrician of Chicago, has set Aug. 2 as the date on which he will retire from the service of the city, as he feels that all his time must be given to the Exposition. The fire alarm system of Chicago is one of the most perfect in the world and its completeness is in a large measure due to the labors of

Prof. Barrett. His loss will be severely felt by the city. Mr. Barrett has taken Mrs. Barrett to the Pacific Coast in the hope that the trip will prove beneficial to her health. Assistant Superintendent Hyland will have charge of the office during the absence of Mr. Barrett.

To Use Electricity.—The motive power for the passenger trains to be run in Jackson Park will be electricity. The Board of Directors of the World's Fair have found it necessary to have a road built to move the visitors from one end of the park to the other, and it has been determined that this intramural railway shall be an electric system. The contract for the road has been awarded to the Western Dummy Electric Company. The road will be an elevated one, double-tracked, something over five miles in length, with stations at intervals of 1,000 feet. The Western Dummy Company is backed largely, it is stated, by the Thomson-Houston Company. The contract calls for carrying 20,000 passengers an hour. The company in its bid proposes to run trains of four cars, including the motor, with a capacity of 320 passengers.

F. De L.

Kansas City, Mo., May 14, 1892.

The Franklin Electric Company has secured the contract for wiring the State House at Topeka, Kan. Simplex wire will be used. Owing to heavy stone walls the work will be extremely difficult.

Hamburg, Ia., has granted the Franklin Electric Company an exclusive franchise for building and operating a 500 incandescent and 30 arc light plant. The work of construction will begin in a few days.

Work on the Construction of the Junction City & Fort Riley electric railway will begin in a few days. When completed the road will be about ten miles long.

The Elgin Telephone Company has opened headquarters in the Merchants' Building, Room 19, 116 La Salle street, where it has a large display of telephone supplies of every description.

Bids for construction work on the Inter-State Elevated railway are now in and the contract will probably be let in a few days. This is for the purpose of changing the entire system into an electric line. Representatives of various electric companies are now here and bidding will be sharp. The entire cost of reconstruction will amount, it is estimated, to $500,000, and it is expected to have the line in operation by July 1.

H. D. E.

Tacoma, Wash., May 11, 1892.

Mr. Geo. D. Snow, superintendent of the Seattle city fire alarm system, has resigned.

The Spokane Street Railway Company will, it is said, extend its lines to Liberty Park.

The Great Northern Telegraph Company's Seattle office has been removed to the Butler Building.

The telegraph line from Centralia, Wash., to Mineral City, in the Mineral Creek mining district, is completed.

Mr. J. M. Bell is now sole proprietor of the Pacific Messenger Company's call service, which is a decided success.

Arlington, Ore., has been bonded in the sum of $10,000 for the purpose of providing electric lights and water supply.

Sprague, Wash., has voted to bond the city for $35,000, which will be expended in the purchase of an electric light plant and the establishing of water works.

The West Coast Phonograph Company, F. T. Cannoll manager, with headquarters in Portland, Ore., will handle the phonographs in the Pacific Northwest.

The Domestic Light, Heat and Power Company, of Seattle, Howard Joslin, manager, is lighting several large buildings from its station in the Squire-Latimer building, using the Edison two-wire system and a Reynolds-Corliss engine.

L. H. Griffiths, president of the Seattle Consolidated Electric Railway Company, has closed a contract with the Northwest Thomson-Houston Electric Company for 10 complete car equipments, w. p. type. Also for two 80 h. p. generators.

New Equipment.—The new electric light equipment, recently installed in its central station by the city of Vancouver, Wash., consists of an Edison 30-arc light dynamo, two Edison dynamos, having a capacity of 500 incandescent lights each, and a new Corliss engine.

The Northwest Thomson-Houston Company has closed a contract with the Spokane Electric Railway Company for 10 complete car equipments, w. p. 30 h. p. type. Also with the Olympia Light and Power Company for a 1,300 light alternating dynamo to replace an Edison.

The Edison Electric Light Company has been granted a franchise to construct and operate an electric lighting system in Tekoa, Wash. The work will be completed as soon as possible. The city has awarded the company the contract to do the pumping for the water works also.

The Tacoma and Steilacoom Railway Company will build a combined waiting room, freight depot and restaurant at the West Shore wharf in Steilacoom. A line of steamers will connect this terminal with the company's club house and summer resort, which will be located not far distant.

Leo Daft, of Seattle, has entered into a contract to build 50 miles of telegraph line for the telegraph department of the Monte Cristo Railway Company, which is building from Snohomish, Wash., to the Monte Cristo mine. He will also install a 50-arc electric light plant in Sultan City, Wash.

The Northwest Electric Supply Company, through Chas. S. Bowie, superintendent, has secured the contract for all of the electrical equipment of Hotel Willipa, in South Bend, Wash. The contract includes the wiring of 100 rooms for incandescent lights and electric calls, annunciator, a 250-light dynamo and a 25-h. p. Ball engine.

The Arnold Novelty Company, of Tacoma, which was recently organized to manufacture the Arnold flexible bracket and other electrical specialties, has elected the following officers: President, W. S. Arnold; secretary and treasurer, J. E. Small; trustees, W. S. Arnold, E. N. Castello, Rush W. Kimball, F. W. Hicks and J. E. Small.

The Walla Walla (Wash.) Electric Light and Gas Company has adopted plans for taking water from a creek five miles above the city, and conducting it through 5,000 feet of pipe to a power station where 225 h. p. will be developed, with a head of 75 feet, and transmitted to the city over wires. Sixty thousand dollars will be spent in improvements.

The Seattle General Electric Company recently put in operation two new Edison generators of 60 kilowatts capacity, which were installed by E. B. Parsons, superintendent of construction, for the Edison General Electric Company. The generators are connected with the company's three-wire system on commercial circuits, running incandescent lights.

Fred. E. Sanders, president of the Grant Street Electric Railway, has closed a contract with the Northwest Thomson-Houston Electric Company for two 125-h. p. railway generators of the multipolar type. Also one 650 light alternating dynamo. Also Westinghouse compound engines aggregating about 350 h. p. capacity. Above machinery is for the new South Seattle line.

The Grant Street Railway Company has commenced the erection of a new power house in South Seattle. It is being constructed of brick and iron, 120 feet square, and will cost $50,000. Thomson-Houston railroad generators will be used and also dynamos, for lighting the line and supplying lights on commercial circuits in South Seattle. Westinghouse engines having a capacity of 375 h. p. will furnish motive power.

The Barnes Heights and Cornell Mountain Railway Company, of Portland, Ore., has arranged to build an electric line from the city park terminus of the Washington street line through Barnes Cañon to the heights above the city, extending about seven miles in all. A branch will be built down the Balch Cañon to connect with the north end of the Washington street line in Willamette Heights. Work will be commenced at once.

Mr. F. B. H. Paine, Tacoma agent of the Edison General Electric Company, has closed a contract with the Puget Sound Pulp and Paper Company for a small Edison incandescent plant to light their mill at Everett, Wash. The installation will be increased later, to light the river front of the town. The Tacoma office is also figuring on estimates for electrically equipping the Snohomish, Skycomish and Spokane Railroad between Everett and Snohomish.

The Point Defiance, Tacoma and Edison Railway Company has closed the contract for equipping the remaining 10 miles of its lines with electricity, and also for a short branch to be built to the cemeteries. Nine new car equipments are to be supplied. The contract approximates $65,000, and will be filled jointly by the Edison and Thomson-Houston companies. Work has begun and will be completed July 1. A power house will not be built at present, but power will be purchased from another company.

The Rainier Railway and Power Company, D. Thomas Denny, general manager, now occupies new offices. The company has ordered of the Edison General Electric Company six 40-h. p. car equipments for its Third street line extensions. This line will extend from the Albert street junction to Brooklyn, a distance of two and a half miles. The company will also replace its Edison direct-current system of commercial lighting with a 2,000 volt alternating system. The equipment for a 2,600 light installation will be ordered of the Edison company.

The Northwest Thomson-Houston Company has closed a contract with the Tillamook Lumbering Company to supply a 650 alternating incandescent light plant for lighting the company's mill and the town of Tillamook, Ore. The Thomson-Houston company has also increased the capacity of the electric light plant in Pullman, Wash., to 650 alternating incandescent lamps and 30 arc. This company also has the contract for equipping the Third street line in Portland, Ore., and has delivered several of the 30 new cars. They are from the Pullman factory, being painted pure white with gilt trimmings. They are double truck cars, 34 feet in length, each equipped with two Thomson-Houston 15-h. p. water proof motors.

G. R. De V.

CANADIAN NOTES.

Ottawa, May 14, 1892.

Electric Light for Morrisburg.—The Town Council of Morrisburg has granted a right to Mr. Albert H. Merkley, of this town, to erect poles and string wires for an electric light service.

Victoria, B. C.—J. S. Anderson, manager of the branch establishment of the Edison General Electric Company in this city, has just disposed of 4-h. p. Edison single reduction car equipments to the N. E. T. & L. Co., Victoria.

Sault Ste. Marie.—Since the electric light has been introduced here it has not been self-sustaining. The company has been running behind and it was for this reason that the present board of directors came to the conclusion a short time ago to shut off the light if it could not be run to pay.

Toronto.—Toronto Junction is to have an electric street railway. Arrangements were made with a Montreal syndicate to have the road begun by May 1 and finished by Sept. 1 of this year. It will be run along Dundas street, down Keele and by Davenport road into the city, connecting with the city's system at Bathurst.

Yarmouth, N. S.—The Yarmouth Street Railway Company has had all of its stock taken up, and has entered into a contract with the Edison company to put in the whole system, engines, dynamos, wire, track, cars, etc. The overhead trolley system will be used, and it is expected to have the line in operation by July 1.

Springhill, N. S.—The electric light system for the town has been completed, and Mr. Lawson, under whose supervision it was constructed, left recently for Dartmouth. Eighteen miles of wire were used. The engine is 60 h. p., Leonard-Ball style, with two dynamos. A third dynamo is to be added soon. The system is owned by the Edison Electric Light Company of Springhill, with a capital of $10,000.

Peterboro, Ont.—The largest electric contract ever awarded in Canada has recently been consummated by the Edison General Electric Company. This was a sale of motor electric car equipments, of the Edison system, to the syndicate consisting of Messrs. James Ross, Everett, McKenzie and others, owners of the Toronto and Montreal street railways. This initial order is only the beginning of a contract that will run into the millions, and which will keep the Edison factories at Peterboro busy for the next three years, it is stated. Last year the Edison company did nearly $800,000 worth of business in Canada, and in Peterboro they employ 600 men in their factories.

Niagara River Electric Road.—A question has arisen as to the rights in the ordnance lands lying along the Canadian side of the Niagara River. The Provincial government granted a charter at its last session to a Toronto syndicate to build an electric road along these lands and with it passed a collateral act granting incidental rights and privileges which were thought to be within the power of the local legislature. A priority of title is claimed by the Dominion government and an engineer, who made the original survey forty years ago, went over the old lines, and it is thought he will report adversely to the rights of the Provincial government. The legal point may interfere with the construction of the electric road.

Hamilton, Ont.—It is the intention of the new electric street railway company to commence work in a few days, building at a point on Main street, near Portage avenue, where it will be necessary to cross the tracks of the Winnipeg Street Railway Company. If injunctions are forthcoming, then will be the time, it is supposed, for the old company to take action, and if action is taken the legal battle will commence. The Hamilton Bridge and Tool Company has been awarded the contract for supplying the iron work for the street railway company's power house. Ahearn & Soper, who constructed the electric railway in Ottawa, and who are well and favorably known to the electrical world in Canada, have secured the contract for the construction and equipment of the electric street railway in Hamilton, Ontario. They control the Westinghouse system for Canada. The order is a very large one, comprising the complete equipment of thirty cars with two 20-h. p. motors to each car. The current will be supplied by three dynamos of 250 h. p. each, and the whole system is to be on a most perfect and adequate scale.

ENGLISH NOTES.

(From Our Own Correspondent.)

London, May 9, 1892.

Portsmouth.—The Portsmouth municipality, which has thrown over a low tension scheme in favor of alternating currents, now proposes to adopt the system of high pressure mains (2,000 volts), feeding into street transformers connected with a low pressure secondary network.

Cable Tariff to Australia.—About a year ago the various Australasian governments and cable companies concerned came to an agreement among themselves by which the cable tariff was reduced by 50 per cent., viz., from 8s to 4s. per word, the governments undertaking to bear half of any loss which might accrue. The result of the first year's working shows that the number of words transmitted has increased by 48 per cent. over the corresponding period of 1890 and 60 per cent. of that of 1889, the revenue having diminished to the extent of £55,000.

The New Telephone Company.—This company is now actively canvassing the metropolis. It offers its expectant *clientèle* trunk line communication to the North, the instruments fitted in the subscribers' houses being adapted both for local and trunk communications. The rates are somewhat higher than those originally mentioned, but as a complete twin wire underground system is promised at the same time as a reduction of about 25 per cent. upon the present charges of the National Company in London, the bait thrown out by the New Telephone Company will no doubt prove tolerably attractive, especially as the charge for the first 5,000 connections will only be £12 12s., and no charge whatever will be made until 3,000 instruments are actually in connection through the exchanges. These rates, however, are only applicable to lines not exceeding one mile in length from the nearest exchange, additional rates being charged for longer lines. The present tariff of the National Company for a single wire overhead service is £20 per annum.

St. Pancras Municipal Central Station.—The central lighting station of the St. Pancras Vestry (which alone of the local authorities has taken into its own hands the supply of electricity), although it has only been in operation for a few months, has already proved a decided financial success. The few arc lights, which were tentatively erected in the centre of the main streets of the district, have given such general satisfaction that it is now proposed to considerably extend them. At a recent meeting of the Vestry the Electricity Committee reported that it had considered the question of supplying electricity during the day for power and other purposes. As a result of their cogitations, the committee recommended that consumers should be supplied with electricity during the day by a separate meter at 3d. per Board of grade unit, *i. e.*, half the price now charged for the night supply. Two difficulties occur to one as arising in connection with this scheme, first, how are day and night meters to be switched on and off—automatically or by a man going around? Secondly, in the case of such a small central station the margin of profit at 3d. per unit must be extremely small, since with the most careful management and in comparatively long established stations it has been found impossible to reduce the "sheer cost" of production appreciably below 2½d. per kilowatt hour.

The Effect of Placing Alternate Current Mains in Iron Pipes.—About three years ago, when the Holborn Restaurant installation was switched on to the Metropolitan Electric Supply Company's mains, an unexpected fall of potential was observed. This was traced to the choking effects of some iron cased conductors which were used as service leads, and was easily cured by placing both conductors in the same pipe. Particulars have now come to hand of a similar phenomenon recently observed when the City of London company attempted to supply a large cutlery establishment in the city, using a separate iron pipe for each main, the fall of volts for a short length amounting to something like 17 times that obtained by multiplying current by resistance. This fact was reported to Prof. Ewing at Cambridge, who pointed out that there were three causes of loss, viz., the self-induction which was enormously increased by the presence of the iron pipe; the eddy current loss, and the loss due to magnetic hysteresis. The thickness of the iron pipe being nearly half an inch, there was considerable magnetic screening, the eddy currents preventing the lines of force from penetrating any distance into the metal. Prof. Ewing estimates that at the middle of the thickness the magnetic force was barely one-thirtieth of its skin value. He further points out that the eddy currents, although in themselves a source of waste, indirectly reduce the total loss, since had it not been for the protection afforded by them the drop in volts due to hysteresis dissipation alone would have been greater than the whole drop actually observed. Mr. Preece, to whom the facts of the case were also communicated, points out that this should serve as a warning to those enthusiasts who are constantly advocating the placing of our chief lines of communication underground in iron pipes. "Long lines of iron piping," he says, "will be death to fast speed telegraphy."

Inquiries from Correspondents.

Queries to be inserted in this column must be of general electrical interest, and must be accompanied by the real name and address, not necessarily for publication, but as a guarantee of good faith. No notice will be taken of questions which involve nothing more than can be found in elementary treatises on the subject. All correspondence should be as brief as is consistent with clearness. Readers are invited to send discussions and answers to these questions, which will be inserted in the column below.

[105.] What causes the E. M. F. on a three-wire system to get higher on one side than on the other, the dynamos running at 110 volts each? Would a ground cause the trouble? The voltage on one side was 140 and on the other 80 volts. J. M.

[106.] How can I find the drop in volts per circular mil per 100 feet with 100 volt pressure at the dynamo? H. R. N.

[107.] I would like to know some rule to cut the voltage down per circular mil, per given number of feet with German silver wire? H. R. N.

[108.] In The Electrical World of April 2, 1887, under "Note on Secondary Generators," the author says the loss due to heating of primary coil by the current $= L\,p = \frac{1}{6}\,C_0^2\,R$. Why is not the loss $= C^2\,R$ as in continuous current generators? H. B. R.

[109.] What is the order for mixing the following nickel solution: Sulphate of nickel, 1 pound; neutral tartrate of ammonia, 11.6 ounces; tannic acid, with ether, 0.8 ounce; water, 16 pints?

E. J.

[110.] What is the difference in composition and manufacture

between carbon dynamo brushes and carbon plates for batteries, and if the latter would do for brushes, would it be well to soak in oil before plating with copper? E. R. R.

[111.] What is meant by the "saturated solution of zinc" in the approved formula for "soldering fluid," published in the report of the committee on safe wiring in the issue of THE ELECTRICAL WORLD for Sept. 19, 1891? H. S. C.

[112.] Is there any way of telling positively whether an armature of either a motor or dynamo is burnt out by testing without disconnecting the commutator, when no surface indication can be found? J. J. S.

[113.] Can I connect a four-pole 110-volt dynamo so that it can, during the day, furnish current to motors wound for 220 volts, that is, can I change the connections in the armature from multiple to series? A. J.

[114.] Is there any rule for calculating the difference of potential between chemical compounds from their elements?

P. J. W.

[115.] What should be the dimensions of the wire coils for the tangent galvanometer described in vol. xviii., No. 22, of THE ELECTRICAL WORLD, in order to give it a wider range? P. J. W.

Answers to Correspondents.

Readers are invited to send discussions regarding, or answers to the queries published in the column above, or with regard to any other live questions on electrical subjects. In answering questions please refer to them by their serial number. Correspondence must be accompanied by the real name and address, not necessarily for publication, but as a guarantee of good faith. Names of correspondents will be printed in full unless otherwise requested. All correspondence should be as brief as is consistent with clearness. THE ELECTRICAL WORLD assumes no responsibility for the opinions expressed by correspondents.

[71.] The induction in the armature of a dynamo is directly dependent upon the strength of the field and the speed at which the wires on the armature cut the lines of force, and a cutting down of the speed will cause a reduction of the voltage and consequently, by Ohm's law, of the current. F. A. K.

[73.] The best method of making a ground connection for light work is to sink a plate of copper, say 18 inches square, in the ground to a depth of about four inches in a place where the earth is as moist as possible. J. S. S.

[76.] Cartridge paper is a good insulator, but not so good as paraffined paper. White shellac may be used only when the magnet is to be baked, as there is always some moisture in the alcohol. With high voltages, such as are used in induction coils, this water is likely to weaken the insulation in some spot and cause trouble.

J. S. S.

[77.] Reversing the direction of each layer of the primary of an induction coil so as to reverse the direction of rotation of the current would completely prevent magnetization, and also prevent induction in the secondary; and with the primary wound continuous and each layer of the secondary reversed you would get no induced currents from the magnetization of the core by the primary. F. A. K.

[80.] With the overhead trolley system the rails and ground both act as return paths, and generally an underground wire is used also. F. A. K.

[81.] The object of the wire at the junction of the rails is to connect the rails electrically and reduce the resistance of the joint.

S. H. R.

[84.] There are many modifications of pastes used, but usually the paste for the positive plate is composed of red lead and that for the negative plate of litharge, both being mixed with sulphuric acid.

S. H. R.

[85.] The positive and negative plates are treated with different materials, as described above. S. H. R.

[86.] The north magnetic pole of the earth does not correspond to the north pole of a magnet; its magnetism is of the opposite kind and corresponds to that of the south pole of a magnet. For this reason the north pole of a magnet has been called by the French the south pole, and Silvanus P. Thompson has designated it in his writings as the "north-seeking pole." A. B.

[93.] A good solution for medical batteries is the following: To eight pints of water add two pints of sulphuric acid (H_2SO_4). While the mixture is still hot stir in one pound of bichromate of potash (K_2CrO_4 CrO_3) and it is ready for use when cold. H. K. B.

[94.] Nickel loses its magnetic properties when heated to 350 degrees C. (662 degrees F.) H. K. B.

News of the Week.

THE TELEPHONE.

A Bill Authorizing the Construction of a telephone line on the coast of Virginia from Cape Charles to Assateague Island, in aid of the preservation of life and property, has been passed in the United States Senate. The bill had previously passed the House.

The Telephone at the World's Fair.—A telephone exchange having about 600 instruments is to be established in the Exposition grounds. About 25 will be public toll telephones, 300 will be for the use of the Exposition officials and employés and the remainder for commercial purposes. The company that puts in the instruments will defray all expenses. Connection with New York will be completed by that time and will be made directly to the grounds.

THE ELECTRIC LIGHT.

Ellicott City, Md., is preparing for electric lights.

Shamokin, Pa., has voted in favor of putting in electric lights.

Dayton, Tenn.—The new city electric light plant is completed and in operation.

Waitsburg, Ore., is to be lighted by electricity, a franchise having been granted.

Pensauken, N. J.—Citizens are agitating the question of lighting the city by electricity.

Winooski, Vt., is to have an electric light plant, plans for the construction of which are being prepared.

Harrisburg, Pa.—The committee on lamps and lights will receive estimates for a new electric light plant.

Sharpsburg, Pa.—The City Council has voted unanimously in favor of putting in an electric light plant to be controlled by the borough.

La Grande, Ore.—The La Grande Edison Electric Company has been granted a 20 years' franchise and will increase the capacity of its plant.

Haywards, Cal.—The electric light works at Hayward, Cal., were recently destroyed by fire. The dynamos were saved, but everything else lost with no insurance.

White River Junction, Vt.—Mrs. O. W. Daley has bought the Miller Water privilege and will put in an electric light plant, which will furnish lights to this place and W. Lebanon and Hartford.

The Monterey Electric Light and Development Company, of Monterey, Cal., has been making improvements in its plant, by building a new power house and adding a new 60-h. p. boiler. This plant has been in successful operation one year and the increase in business has warranted the new improvements.

The Economy Light and Power Company, at Joliet, Ill., has just completed the finest electric lighting and power plant in the State outside of Chicago at Joliet. L. E. Ingalls, J. C. McMullen and John L. Norton comprise the company, and the capital stock is $400,000. The company operates 425 arc and 4,000 incandescent lights

THE ELECTRIC RAILWAY.

The proposed electric line between Media and Chester, Pa., is to be constructed at once, the contract having already been let.

Newburyport, Mass.—E. P. Shaw is negotiating for the franchise of the West Newbury Street Railway, and if successful will make improvements.

Binghamton, N. Y.—The Binghamton & Port Dickinson Railway Company has petitioned to use the electric trolley system of motive power on its road.

Bath, Me.—W. M. Brown and Chief Engineer W. J. Wilson, of Eastern Electric Supply and Construction Company, are interested in a new electric road which is to be built here.

Pittsburgh, Pa.—The Bloomfield Street Railway, with a capital of $12,000, will construct a line along Edmund street and Liberty street to Penn avenue. Electricity will be the motive power. Joshua Rhodes, John Taggart and Wm. M. Adams are interested.

Philadelphia, Pa.—The Delaware County & Philadelphia Electric Railway Company, capital $120,000, will construct a road from Darby to Clifton Heights, to Media, to Newton square, to Lansdowne and to Darby, a distance of 20 miles.

Chicago & St. Louis Electric Road.—It is announced that grading will begin near Edinburg next month on the Chicago & St. Louis Air Line Electric Railway, and proceed toward St. Louis and Chicago. The principal objection raised to the road has been the great danger of collisions at railway crossings, and death at highway crossings, on account of the speed proposed. Plans are now being drawn for 20 bridges for the electric road over steam railways, to do away with all grade crossings.

PERSONALS.

Mr. E. P. Wright, superintendent of the Western Union telegraph office, at Cleveland, O., has tendered his resignation to take effect June 1.

Mr. B. B. Jenkins, who has been with the Barrie Electric Light Company, of Barrie, Ont., for some time, has taken a position with the Niagara Falls Power Company.

Mr. Edward A. Maher, ex-Mayor of Albany, N. Y., and manager of the Albany Electric Illuminating Company, has resigned to accept the position of president of the "Huckleberry" system of roads in the Annexed District of New York City.

Mr. Charles E. Sharp has been appointed manager of the Southern Electrical Supply Company. Mr. Sharp is a conscientious painstaking business man, and since his appointment (May 1st), has got back a good many of the old customers of the Southern, besides getting a good many new ones.

Mr. William Hazelton, 3d, has been appointed Assistant General Manager of the Short Electric Railway Company. Mr. Hazelton has been in the employ of the company for about a year, having his headquarters at Philadelphia, managing a large and very important eastern territory for the company. His promotion is well deserved, and he is receiving congratulations from the electrical fraternity generally. Mr. Hazelton will move to Cleveland, O., immediately, and pending the growth and training of Wm. Hazelton, 4th, the Philadelphia office will be placed under the management of Mr. C. C. Curtiss, of the New York office.

MISCELLANEOUS NOTES.

The American Association of Inventors and Manufacturers.—Mr. Geo. C. Maynard, secretary of this association, is sending out a circular letter calling attention to the growth of the organization, its objects, and to the fact that a large increase in membership is desired. Arrangements have been made for holding an International Congress of Inventors under the auspices of this association, at Chicago, during the World's Columbian Exposition.

Inquiry in Congress as to the legality of the bids made for furnishing electric lighting at the World's Fair is the subject matter of a resolution of inquiry offered in the House by Mr. Crain, of Texas, calling on the Attorney-General for information as to whether the Edison General Electric Company, the Thomson-Houston Electric Company, or the General Electric Company have violated the provisions of the Anti-Trust act in submitting proposals for doing electric lighting at the World's Fair.

Prize for a New Primary Battery.—The favorable reception which inventors have given to the International Prize competition for a prize of 2,000 francs offered by *L'Elettricita* for a new primary battery, leads to the hope that the competitors will be numerous, but the condition that the new electro-motor must comply with (that the cost per kilowatt hour shall not exceed 1 franc) gives rise to the opinion that many inventors will hesitate to attempt the problem. The management of *L'Elettricita* announces that the primary batteries which approach nearest to the desired conditions will be considered and propositions made to the inventors with reference to patenting them, and also manufacturing and placing them successfully on the market.

Industrial and Trade Notes.

George Cutter reports that he is supplying hundreds of the Morris poletops to some of the new electric roads in the East.

The Thomson-Houston Carbon Company will rebuild its works at Fremont, O., which were recently destroyed by fire.

The Bryant Electric Company, of Bridgeport, Conn., has a new catalogue in the publisher's hands which it expects to have ready to send out to its friends and patrons by June 1.

Three hundred and fifty lamps in three days is the record of sales of the "Ward" for Monday, Tuesday and Wednesday of last week. Good management and a good article is the reason.

Keuffel & Esser Co. are temporarily occupying the premises 125 Fulton street and 44 Ann street, New York, pending the erection of a new, larger and more commodious building on the former site occupied by the company, 127 Fulton street and 42 Ann street.

The Schultz Belting Company, through A. B. Lawrence, its New York agent, has recently placed 200 feet of 16-in. belt in the new electric light plant of Macy & Co., has received a third order for the Ocean Grove camp-meeting plant, and another large order from the Red Star line, besides numerous smaller orders.

The Lunkenheimer Brass Manufacturing Company, Cincinnati, O., is sending out a new illustrated catalogue and price list of the brass and iron goods and specialties for steam, water, gas, oils, etc., which the company manufactures. The catalogue is neatly gotten up, and is a credit to the company which it represents.

The Mortimer Norden Electrical Company has recently been organized and has offices at 4 East Sixtieth street, New York. The company will do a general business in engineering and contracting for electrical work. Mr. Norden was formerly with The E. S. Greeley & Co., the Edison company and at one time was inspector for the Electric Power Company.

B. W. Payne & Sons, of Elmira, N. Y., have removed their New York office from 45 to 41 Dey street, where larger quarters will enable them to display their engines to advantage. This company has lately installed a 100-h. p. Payne Corliss engine in a new factory on Ninety-fifth street, New York; a 4-h. p. engine in Hoboken, and a 25-h. p. vertical engine in the Seabury Building, New York City.

The Central Electric Company reports that it has secured the order through the Brush Electric Company for 32 miles Acme lead Okonite cable for the South Park Commissioners of Chicago, the wire to be used in carrying current for the lighting of the boulevards to the World's Fair Grounds, Okonite being selected because of its high quality and being able to conform to the stringent guarantees required.

The Electrical Decorating Company has been recently organized for the purpose of designing artistic effects in incandescent electric lighting for receptions, weddings, dinners, fairs, show windows and entertainments. The company starts out with very flattering success, and without doubt will be accorded a liberal patronage. The offices of the company are at 163 Fulton street, New York, and 662 Nostrand avenue, Brooklyn.

The Electric Construction and Supply Company has just brought out a new lamp of the "Ward" pattern, but under three feet long, which will fill a long felt want in buildings with low ceilings. They are also offering to the trade a new style double carbon lamp, manufactured under a license from the Brush company, which has many very important features. Another new lamp is the "Steroptician," which will be in great demand for advertising purposes, etc.

The Edison Illuminating Company, of Detroit, Mich., one of the model electric light plants in this country, about one year ago purchased of John T. Noye, Manufacturing Company, of Buffalo, N. Y., through Fairbanks, Morse & Company, of Chicago, one 400 h. p. tandem compound non-condensing engine, and it is stated within a month of the time the engine was first set it was given a regular load of 470 h. p and has given such good satisfaction that the company has placed an order for a second engine of the same type as the one previously furnished them.

The Hall Signal Company some time ago placed six crossing bells at Elmira, N. Y., on the Delaware, Lackawanna & Western Railroad, with the understanding that if satisfactory after a thorough trial they should be adopted. Twenty-five more have been ordered. This company has also protected with its electric signals the Pecos Viaduct near El Paso, Tex., on the Southern Pacific Railroad. Its new factory at Garwood, near Cranford, N. J., is being rapidly pushed forward, and when finished will employ about 300 men.

The Automatic Switch Company, of Baltimore, has received a letter from Hershberg, Hollander & Co., of Baltimore, one of the first users of the new Whittingham Automatic Motor Starter, which expresses entire satisfaction with that piece of apparatus. The motor, upon which it is used is a 10 k. w. 110-volt Wenstrom, which runs a large paint mill, frequently consuming 90 ampères for 14 hours, and often stopping and starting. Previous to the employment of the Whittingham starter, at every stop the fuse would be blown before resistance could be thrown in, but now no trouble is experienced in that line.

The Purity Oil Filter Manufacturing Company, of Pittsburgh, Pa., report that it has recently sold the Ideal Oil Refiner to the following parties: The Vandegrift Building, Pittsburgh; Traction Company and Central District Telephone Company, of Pittsburgh; New Castle (Pa.) Wire Nail Company; Pittsburgh Wire Company; Braddock, Pa.; Pacific Rolling Mill Company and California Electric Company, of San Francisco, Cal.; Golden Reward Mining Company, Deadwood, S. Dak.; Henry Likly & Co., Rochester, N. Y., and the Thomson-Houston Electric Company, of Syracuse, for Little Falls (N. Y.) Electric Light Company.

The Accounting Department.—In many of the larger electrical establishments that well-known time saver, the comptometer, is always gladly welcomed both for the rapidity and the accuracy with which it performs addition, subtraction, multiplication division, interest, percentage, discount, etc., and for the entire relief from mental strain afforded. In many an inventory of stock it has accomplished the work of two men and many new methods of utilizing its work will quickly suggest themselves to an operator after a few days' use. The Felt & Tarrant Company, 52 Illinois street, Chicago, will send a copy of their pamphlet A to any one interested in the subject.

Electric Launch at the Crystal Palace Exhibition.—Messrs. Woodhouse & Rawson, London, have lately added to their stand at the Crystal Palace an electric launch, and the following particulars concerning it may be of interest to our readers. The Lily, as she is named, is 28 feet long, and has a beam of 5 feet 6 inches, a depth of 2 feet 10 inches and a draught of 2 feet. The sides of the boat are carvel built, of mahogany, with American elm keel and timbers, and she has an oak stern, stern post and dead wood. The electrical equipment consists of a 2-h. p. "W. & R." motor, supplied with current from 30 "Epstein" cells. Her weight complete is 25 hundredweight, she will hold from 12 to 15 passengers, and with one charging, which occupies about four hours, will run at full speed (seven miles an hour) for five hours.

Campbell & Zell Company, of Baltimore, Md., reports that notwithstanding the recent extensive additions to its works, which more than doubles the capacity, it is crowded with orders for Zell improved water tube safety boilers and has recently closed contracts for the following plants: The Central Railway Company, 675 h. p., and the Baltimore City Passenger Railway Company, Baltimore, Md., 1,800 h. p.; the South Park Electric Light Works, Chicago, Ill., 450 h. p.; the Michigan Brass and Iron Works, Detroit, Mich., 150 h. p. Besides a number of smaller boilers, including two 40-h. p. boilers for Otto Sutro & Co. and one 25-h. p. boiler for the

Thos. Wilson Sanitarium for Children, both of Baltimore. In addition to this a contract has been made with the World's Columbian Exposition, at Chicago, for 2,500-h. p. Zell boilers for supplying power at the fair.

The Electric Appliance Company is getting in shape for the summer trade on fan motors and has secured the agency for the Meston alternating current fan motor, which on account of its reputation as the first alternating fan motor on the market is apparently going to have a very large sale the coming summer. The motor has been very much improved over last year's model. Some of its special features are regulation of speed at will, self-oiling bearings and carbon brushes which will last an entire season. No cost has been spared in the manufacture of the machine and it is certainly a very handsome fan motor. The Electric Appliance Company is now exhibiting the first one of the 1892 pattern that has been received in Chicago, and it is exciting favorable comment rom all who have seen it.

The Detroit Electrical Works has been awarded the contract by the Citizens' Street Railway Company, of Detroit, for the entire equipment of the Jefferson avenue line. The steam plant is to consist of three horizontal, return tubular boilers and three 12-24 × 14 Westinghouse automatic compound engines with necessary apparatus, such as pump, feed-water heater, etc. The electric plant will be composed of three 100-k. w. multipolar railway generators of the Detroit Electrical Works' make and an improved slate switchboard with all necessary instruments. For overhead construction two No. 0 B. & S. hard drawn copper wires will be used, supported on Milliken poles. Twelve 40-h. p. Detroit motors will form the motor equipment. This will be the first electrical line through the centre of the city. It is expected to be in operation in about 75 days. The Detroit company has nearly completed the extensions to its works.

W. R. Fleming & Co., formerly of 174 Fulton street, and now removed to the new *Mail and Express* building, corner Fulton street and Broadway, New York, are installing two of their "Ideal" self-oiling high speed engines in the new naval observatory at Georgetown Heights, Washington, D. C. As is well known, there is no more exacting customer than the government, and these engines were selected by Lieut. A. V. Zane of the Naval Department at Washington. After bids were received he visited this city to investigate the merits of the different engines, and personally visited the engine rooms to see them in operation. He also visited other cities for the same purpose, and on his return to Washington the "Ideal" engines were ordered. His reason for ordering these engines were, as he expressed it, for their perfectly noiseless running, as the officers in the observatory, in order to use their instruments with accuracy, can have no noise or vibration of any kind (which would affect their proper use) in the building, and on investigation Mr. Zane thought these engines exactly suited to his purpose. The service required is very exacting, but they are fully equal to any demands that may be made upon them, as can be proved from the many fine electric plants now being noiselessly run by the "Ideal" engine in New York and other cities.

The Page Belting Company reports in a recent communication to THE ELECTRICAL WORLD the following recent orders: A 30-inch for the Pearson Cordage Company, Roxbury, Mass.; a 29-inch for the Pontoosuc Woolen Manufacturing Company, Pittsfield, Mass.; a 21-inch for Quincy Market Cold Storage Company, Boston; a 20-inch for Tomkins Hardware Company, Leadville, Colo.; a 34-inch for Chicago; two 18-inch and other belts for Chicago; a complete new mill outfit for Point Pleasant Furniture Company, Point Pleasant, W. Va., including a 20-inch main belt; one 18-inch for Gouverneur Machinery Company, Gouverneur, N. Y.; a 24-inch for Toledo Rubber Company, Toledo, O.; a 34-inch and several other belts for Nordberg Manufacturing Company, Webster City, Ia.; several large belts for the Victor Knitting Mill Company, Cohoes, N. Y. Of patent Acme link belts, the following are among recent shipments: a 16 inch for Chicago, also a 15-inch for the same place; a 14-inch for Pleasant Hill, N. C.; one to Columbia, S. C.; one to Lebanon, Penn.; one to New Brunswick, N. J. The company also recently furnished for a plant in South Dakota probably the largest link belt ever made, being 181 feet long and 28 inches wide. Of Eureka dynamo, the following are a few of recent orders filled: Two to Galveston, Tex; one to Chattanooga, Tenn.; two to Roanoke, Va.; one to Seymour, Conn.; nine belts to Brooklyn City Railroad Company, Brooklyn, N. Y.; four to United States Electric Light Company, Washington, D. C.; two to Staten Island Light, Heat and Power Company, Port Richmond, N. Y.; three to the Prudential Insurance Company, Newark, N. J. Following are a few recent orders filled for regular dynamo double belting: One for Pennsylvania Railroad Company, Camden, N. J.; one for Bath, N. H; one for Chicago; one for Red Star Line repair shops, Jersey City, N. J.; one for the People's Electric Light Company, Trenton, N. J.

Business Notices.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Molds for casting battery zincs are made of iron and steel. We have just completed sets for the "D'Infreville Patent Wasteless Zinc," costing over $40 each. H. Brooke, 44 Barclay street.

35-light, 2,000-c. p. American arc dynamo, in good condition, for sale at a bargain; also 750-light Westinghouse alternator, with station appliances. Address E. T. Pardee, 10 Butler Building, Syracuse, N. Y.

The Consolidated Electric Storage Company's factory at Camden, N. J., was never kept so busy before as it is at present. It is making several types of battery, many of them new and specially adapted for every branch of the industry.

In Partrick & Carter Co.'s advertisement this week will be found an illustration of their patent needle annunciator for house use. The firm's catalogue shows many styles of cases in which they rmake this annunciator, and a copy should be in the hands of the trade everywhere.

Burlington Route—New Service.—A through Pullman sleeping car, Chicago to San Francisco, is a feature of the Burlington's new service. This car leaves Chicago daily on the fast train at 1:00 P. M., and runs via Denver, Colorado Springs, Leadville, Glenwood Springs, Salt Lake City and Ogden, arriving in San Francisco at 11:45 A. M., less than four days *en route*.

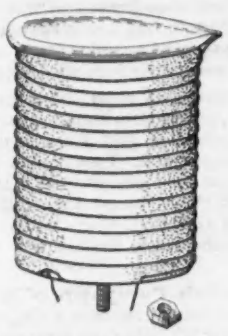
OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

[In Charge of W. A. Rosenbaum, 177 Times Bldg., N. Y.]

U. S. PATENTS ISSUED MAY 10, 1892.

474,355. Electric Railway; Charles H. Baker, Lake Geneva, Wis. Application filed Oct. 30, 1891. In an electric railway, the combination, with a conduit and electrical conductors supported upon each side of the commutating slot, of the motor car provided with a hollow tubular upright, a hollow sheave-bar depending from said upright, a sliding plow working in the lower end of said bar and provided with contact devices, and a counterbalancing connection secured to said plow and passing through said hollow upright into the casing.

474,375. Trolley-Wire Support; Owen F. Evans, Columbus, O. Application filed Jan. 24, 1891. One object of this invention consists in employing the electric conducting-wire as a support for the trolley wire, and thus arranging the wires in a neat and compact manner.



NO. 474,398.—ELECTRICALLY HEATED VESSEL.

474,388. Dynamo-Electric Machine or Motor; Charles D. Jenney, Indianapolis, Ind. Application filed Jan. 8, 1891. The combination, in a dynamo-electric machine or motor, of an integral frame-work, surrounding the field-magnet and fitted at determinate points to evenly support the plates of which said field magnet is composed, and said field magnet composed of plates of sheet metal stamped out in the desired form and fitted within said integral frame.

474,398. Electrically Heated Vessel; Willis Mitchell, Malden, Mass. Application filed Sept. 5, 1891. In combination with an inner receptacle and an outer shell, an electrical resistance in the space between them, insulating sleeves extending through the shell, and conductors extending through the sleeves and connected to the ends of the resistance for establishing an electrical circuit through the latter. (See illustration.)

474,403. Truck for Electrically Propelled Vehicles; Louis Pfinget, Boston, Mass. Application filed Oct. 6, 1891. A weight detachably mounted on the free axle of the motor-truck to counterbalance the weight of the motor at the companion axle.

474,447. Electric Speed Regulator; Application filed Sept. 26, 1891. The invention consists in a special mode of operating a regulator comprising an electric generator which is driven by the mechanism to which it is applied or responsive to speed changes in the same, and the principle of the invention is that the action of the regulator (which may consist of the electric generator alone in certain cases or an electric generator used in conjunction with auxiliary appliances whose operation it controls) is dependent directly upon the speed at which the revolving portion of the generator runs, and therefore upon the torque exerted between the stationary and revolving portions of the generator.

474,454. Exciting Fluid for Galvanic Battery; Carl Lütcke, Jr. Application filed April 17, 1890. In a galvanic battery, the exciting fluid consisting of a concentrated solution of one or several chlorides, such as copper, iron, zinc, etc., in combination with two or three parts, by weight, of nitrate of mercury.

474,468. Electric Conduit; Augustus Bruner, Indianapolis, Ind. Application filed March 7, 1892. An underground conduit for wires or cables, composed of one or more series of clay pipes, their ends abutting and forming a joint, such joints closed by a flexible metallic band slit on one side and adapted to be sprung around the joint, such pipes surrounded by cement.

474,469. Lightning Arrester; Malcolm Dickerson, Fort Wayne, Ind. Application filed March 14, 1892. A discharging device for lightning or currents of extraordinary potential having separated points, between which is an interposed insulating liquid, whereby the high potential current may escape by disruptive discharge and an arc be prevented or extinguished by the closing in of the liquid. (See illustration.)

474,472. Cleaning Brush for Electric Railways; Randolph M. Hunter, Philadelphia, Pa. Application filed March 18, 1886. The object of this invention is to provide an electrically-propelled vehicle or car with a depending holder or shank entering the slot of the conduit, and provided with a brush substantially fitting said conduit, whereby as the vehicle moves along any dirt may be swept through the conduit until it falls into a well, from which it can be extracted.

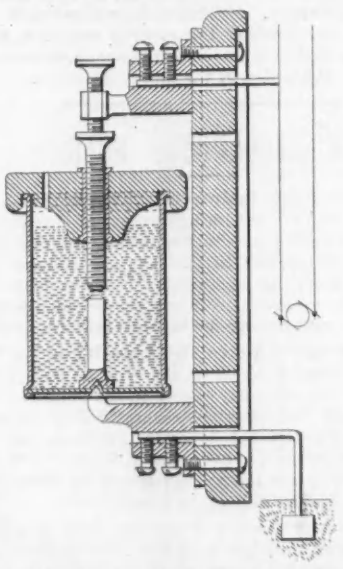
474,473. Electric Snap-Switch; George K. Hutchins, Baltimore, Md. Application filed Dec. 26, 1889. The combination of a non-conducting brush carrier capable of being rotated, having pivoted contact brushes, each brush actuated by a separate spring set against said carrier and bearing against said brush, and a base with terminal plates capable of being opened or closed electrically by each brush independently.

474,523. Electrical Indicator John W. Gibbony, Lynn, Mass. Application filed Dec. 10, 1891. This invention consists in employing several magnets or a set of magnets for actuating the different parts of mechanism, two or more of which are each provided with a retarding or counter magnetizing circuit, and in so constructing these magnets that they will operate at different time intervals, that is, they will actuate their armatures in sequence when energized by current.

474,528. Locking Device for Switch and Signal Operating Mechanism; Thomas H. Patenall, Rahway, N. J. Application filed Jan. 2, 1892. This invention relates to an improvement in a locking device for use in connection with switch and signal operating mechanism, with a view to preventing the possibility of changing the switch and route after it is once set and the signal given to proceed until the train has responded to the meaning of such signal. The locking device is intended to be operated after the switch has been thrown and the facing point lock and detector bar adjusted and immediately before the signal has been set.

474,541. Electric Switch; Carl Alfred Paul Willing and Richard Julius George Violet, Berlin, Germany. Application filed May 26, 1891. Improvements in the details of "snap" switches.

474,542. Thermostat; Archibald H. Brintnell, Toronto, Canada. Application filed April 11, 1891. The object of the invention is to design a thermostat which will be actuated with great rapidity to produce either a trouble or warning alarm and a fire alarm, according to the space the diaphragms are caused to recede from each other by the heat; and it consists, essentially, of forming the ends of the body of the thermostat of two diaphragms, which are secured in an outer binding ring or casing, and, furthermore, of securing within the body of the thermostat two spring-arms adjustably held in position by set-screws passing through the diaphragms, one spring-arm having an auxiliary arm, between the end of which and the said arm the end of the other spring arm interposes, the said arms being suitably insulated from the diaphragms and so arranged with connecting pieces to the diaphragm that when one or both diaphragms are moved apart by the heat the ends of the spring-arms spring apart sufficiently far to either break the electrical current and form an open circuit over the trouble-alarm wire and so ring it or come in contact with the auxiliary arm, and thus form a closed circuit and permit the electrical current to pass from the battery over the fire alarm wire and so ring it.



NO. 474,469.—LIGHTNING ARRESTER.

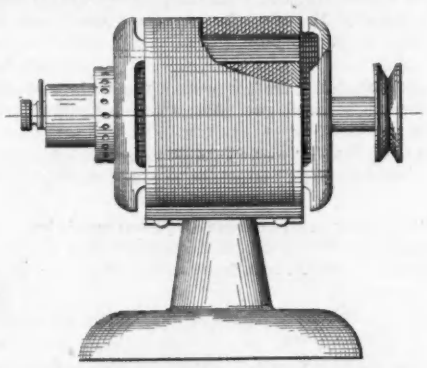
474,552. Trolley for Electric Railways; Charles E. Friel, Boston, Mass. Application filed March 19, 1892. The connection between the grooved wheel and the arm consists of a disc secured to the upper end of the arm, on which a similar disc is pivoted, carrying the wheel, the two plates forming friction-plates, and of a spring connection between the upper disc and the arm, to normally hold the wheel in the same vertical plane as the arm, but allowing it to turn to one side or the other, the connection between the plates being such as to limit the movement of the upper relative to the lower, the spring connection consisting of a flat spring secured at one end to the arm a considerable distance below the wheel, and the other end having a bearing adapted to register with a slotted arm of the upper plate.

474,569. Insulating Coupling; Albert Anderson, Boston, Mass. Application filed March 21, 1892. In accordance with my invention, the insulating connection or coupling is composed of two members or parts electrically separated from each other by insulating material and interlocked or locked together, whereby a flat and substantially wide surface is obtained, between which the insulating material is compressed when the insulator is placed under tension.

474,584. Connection for Electric Conductors; Charles W. Toby, New Bedford, Mass. Application filed Jan. 28, 1891. A connection for electric conductors, consisting of a metal clip adapted to be clamped upon the conductors and having its face tinned and resined.

474,600. Commutator Brush; Robert Hirsch and Herman Meminger, Milwaukee, Wis. Application filed Dec. 11, 1891. A commutator brush, composed of a mixture of refined clay, graphite, carbonized oil or sugar and wax covered with a metallic coating.

474,623. Circuit Controller for Electric Motors; William S. Andrews, New York. Application filed May 27, 1891. The combination of a switch arm, a contact spring or plate at one end thereof, a contact co-operating with said spring or plate and a contact spring or plate at the opposite end of the switch arm, the latter spring bearing on a contact at each end.



NO. 474,787.—ELECTRIC MACHINE.

474,624. Dynamo-Electric Machine or Motor; Jos. D. F. Andrews, London, England. Application filed Jan. 18, 1892. A dynamo-electric machine or motor provided with an armature, having a ring core and two or more pairs of field magnet poles, the armature coils surrounding the core and connected together and to the commutator, so that all coils in approximately the same phase act together in series.

474,632. Electrical Switchboard; Louis A. Fehr, New York. Application filed Nov. 28, 1890. The combination of a plurality of sources of electrical supply, a plurality of work circuits, a pivoted switch connected to each work circuit and two sets of contact pieces for each switch, one set of which contact pieces are connected each to a terminal of a supply circuit, the other set of contact pieces being connected each to a terminal of a work circuit, no contact piece being connected with more than one such terminal.

474,667. Electric Lamp Socket; William David Kurz and Hans Amundson, La Crosse, Wis. Application filed Sept. 26, 1891. A lamp-socket, composed of a coil of wire having one end of the wire extended to form an arm, by means of which the socket is secured to the support and having the other end of the wire extended to form the projection for the finger to obtain a purchase upon when removing or attaching the lamp.

474,670. Automatic Fire Alarm; Morris Martin, Malden, Mass. Application filed Feb. 21, 1887. The present invention is embodied in an apparatus operating upon the closed circuit plan, in which, normally, a current flows over the circuit that controls the operation of the signal or alarm, and in apparatus of this class operating on this plan the thermostatic instruments commonly operate by opening the circuit to cause an alarm to be sounded, and consequently any accidental break in the circuit not produced by a thermostat will also cause the alarm to be sounded.

474,673. Electric Heat Alarm; Joseph Meyer, Jersey City, N. J. Application filed Dec. 14, 1891. This device consists more particularly in the employment of a column of mercury, which, by its expansion above a certain point completes an electrical circuit, and by means of an alarm, forming a part of such circuit, indicates that the temperature of the apartment or building in which it is placed has been raised to an undue degree.

474,706. Automatic Repeater; Richard Watkins, Sacramento, Cal. Application filed Feb. 2, 1892. A repeater for a secondary circuit, consisting of adjustable screws forming terminals of the circuit and extending within a casing, an interposed contact lever between the terminals, a circuit carrying spring in contact with said lever, and for operating said lever by a moving part of the main circuit.

474,787. Electric Machine; Herbert A. Wagner and Ferdinand Schwedtmann, St. Louis, Mo. Application filed May 15, 1891. The combination, in a magneto-electrical machine, of a cylindrical field magnet, and armature surrounded thereby, and cap pieces supporting said armature and its shaft from said cylindrical field magnet and with said field magnet completely incasing said armature, one of said cap pieces being provided with sockets containing longitudinally movable commutator rods or brushes, a commutator upon which said brushes bear in a plane at right angles to the axis of the armature, spiral springs carried by the latter-mentioned cap pieces for holding said commutator brushes against the segments of the commutator, and binding screws, also carried by said cap pieces, bearing against the spiral springs for adjusting the commutator rods against the commutator segments, and forming the terminal connections of the armature coils. (See illustration.)

474,797. Electrical Heater; Willis Mitchell, Malden, Mass. Application filed Dec. 14, 1891. In combination with a tubular electric heater having a spider within it, a stand connected detachably to said spider.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.